FORMULA 1 Mercedes technical director, James Allison, on the woes of the W14

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The Las Vegas round of the Formula 1 World Championship was touted as the series' showpiece race, but some involved felt the spectacle detracted from the racing

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Road and track

Proof positive that public roads are more dangerous than race circuits

The Red Bull Ring, formerly the Österreichring and A1 Ring, brings back a lot of mixed emotions and is a place I've been going to for almost 40 years.

One of the lighter memories was coming out of a country restaurant to find a rival team manager's rental car in an 'elevated' position on four stout beer hall tables!

In 1983, however, I was there with Eddie Jordan and a pair of F3 cars supporting the Austrian GP. Martin Brundle and Allen Berg qualified and finished first and second, beating local hero Gerhard Berger by a country mile.

Jackie Stewart was overheard on that occasion saying to Ken Tyrrell, 'That Brundle boy looks really good in a car to me'. Martin would be in a Tyrrell F1 car the following year.

Eddie, Martin and I flew back on the Sunday evening, with the rest of the team following by road on the Monday. However, as we got back to work on Monday morning, we heard that our Mercedes transporter had run out of brakes on one of the mountain passes and plunged down a ravine. Martin's number one mechanic, Rob, had been killed and two other crew members were in hospital.

By lunchtime, I was back at Heathrow with colleague, Jim Wright, on my way to pick up whatever was left. The scene that greeted us was like an air crash, just pieces everywhere.

After the hospital visits, we worked in torrential rain to load any salvageable parts back onto a truck and return them to Silverstone. Our task then was to rebuild a number of lives, a team and two cars in about a week to take on Ayrton Senna at the next British F3 round. We didn't win, but came second and stayed in the title hunt.

As hard as it was, we were quite sure that is what Rob would have wanted.

In 1985, I was running an F3000 car, again supporting the GP. I looked up from my work in the paddock one day to see Italian driver, Andrea de Cesaris, cartwheeling his Ligier over the wet grass. He landed the right way up, got out of the car and walked past me, helmet in hand, to the F1 paddock, mud all down his back to the waist.

Five years previous to this, on my very first motor racing test session, I'd helped get him out of his F3 car on the wrong side of a spectator bank at the Goodwood circuit. He had 'previous', and would continue to have many more major incidents, miraculously without major injury.

Having survived one of the most crash-strewn lives in motorsport, he lost his life in a motorcycle accident on the road near Rome in 2014.

In 1997, I was doing a private test with Dr Thomas Bscher in a McLaren F1 GTR. We had just concluded a successful test when I received a telephone call to say my 17-year-old son had sustained serious leg injuries in a road motorcycle incident. I couldn't get back until the following day so that was a very anxious night.

After a few operations and eight weeks in plaster, he made a recovery good enough to have a 20-year career in motorcycle racing, where his worst injury on a circuit was a trip to outpatients to dress a grazed knuckle after catching his hand under the handlebars during a little 'lowside'.

Eddie pumps up Allen Berg, while I check Martin Brundle is good to go from pole

Driving with Bscher (who would go on to be the chairman of Bugatti) at Le Mans that year was 'big' John Nielsen, the first Dane to win the race (in 1990). John had very few accidents but, when he did, they tended to be big.

Later that same year at Suzuka, John was 'encouraged to take a wider line' by a back marker at the long right prior to the Spoon curve and disappeared into the tyre wall big time. The red flag came out and all we could see on the circuit cameras was a huge pile of tyres with a wisp of steam emerging. That was until John emerged through the windscreen aperture and stood on the dashboard like the Incredible Hulk!

It is inevitable in a career working with long-distance sportscars, given the distances they cover, that I should have first-hand experience of a number of accidents.

One of the biggest was a 230mph Mulsanne Straight incident that befell Win Percy in 1986. The car sustained a puncture during the night and a rear tyre exploded, taking out all the rear bodywork and, crucially, the rear wing. The car rolled multiple times but was fortunately retained by the somewhat low barriers until the main chassis and motor came to rest the right way up. Win then carefully unplugged the radio, hit the release buckle on his belts, hopped over the barrier and had a quiet sit down in the woods.

In the three-year Bentley Le Mans programme from 2001, the cars travelled at racing speed for over 100,000kms. Enough, as it transpired, to have one major accident in each of the three years.

In 2001, a brand-new car inexplicably turned right into a barrier within a few hundred metres of its launch, a top wishbone penetrating the cockpit area, thankfully without injury.

In 2002, mid-way through a 36-hour test at Paul Ricard, Eric van de Poele had a rear wheel come loose at night, which caused the car to spin at high speed on entry to the fast Signes corner. The car cleared all the circuit's safety features and ended upside down on a low wall outside the circuit.

The Bentley was built with a full carbon safety cell, which in many ways replicated what the Halo was mandated to do in F1 some two decades later. The carbon a-pillar took the brunt of the impact and the driver was unharmed. So much so, the following day he recorded the quickest time of the day in the other test car.

Then there was Johnny Herbert at Jerez in early 2003. At the end of a run on test tyres he went off, skipping the gravel trap and tyre wall and impacting the concrete wall with four times the energy of the FIA frontal impact test. He suffered bruising from the seat belts and two black eyes, but no other injuries in what he says was the *second* biggest shunt of his career.

My conclusion is that it is safer to have incidents on the circuit than on the road, and to therefore drive accordingly.

It is inevitable in a career working with sportscars, given the distances they cover, that I should have first-hand experience of a number of accidents

How NASCAR is approaching the ongoing development of its Next Gen car for short track and road course work

By ERIC JACUZZI

Coming up short

With the birth of the Next Gen car for the start of the 2022 season, NASCAR embarked on one of its most ambitious resets of the sport, and industry, in decades. With teams no longer constructing their own chassis and components, the aim was to help them financially, while ensuring on-track competition would reach heights never seen before. The goal is that on any given weekend, every team has a chance to win.

With its dramatic design departure from the Gen 6 vehicle, the hope that the Next Gen would increase competition across the schedule largely held true, with the 2023 season featuring 15 different winners, and over 150,000 total passes within the top 15 positions during the season's races.

NASCAR diligently reviews every race, both from a technical perspective and from television / fan feedback. In general, at large and fast tracks, the new car performed admirably in the eyes of NASCAR followers, with races trending above average in terms of fan scoring. Short tracks and road courses, however, have been more challenging, albeit with some notable exceptions.

That, therefore, is where development has been focussed for year two. But improving the racing at these more demanding courses is not a one-dimensional concept, and solving it will take efforts in all areas of the car, beyond just the aerodynamics.

Short tracks have always been an integral part of NASCAR, which recently concluded its diamond anniversary season. While lacking a strict definition, oval tracks under one mile are typically considered short. However, there is a great diversity in their characteristics, even with the limitation on length.

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Short tracks don't mean flat ones: Bristol Motor Speedway's highly banked half-mile oval is well known for putting the greatest suspension loading on the cars of all the tracks on the calendar

For example, the season-opening Busch Light Clash at the LA Memorial Coliseum is a flat, 0.25-mile affair. Contrast this with Bristol's highly banked half mile, which sees the greatest loading on suspension of any track on the calendar, and one can see how diverse a challenge short tracks present.

Apex speeds vary greatly as well – from 40 to 130mph – adding further to the degree to which the tracks vary. As such, aerodynamics plays a varying role in its contribution to the racing on track – at some places very little, but increasing in importance as speeds rise.

Short tracks are also known for close, door-to-door racing, and the drama and excitement that come with that are critical to what makes NASCAR.

The short challenge

The initial short track and road course races in early 2022 were generally below average in terms of fan ratings and the quantifiable metrics that NASCAR monitors week to week. This was also apparent from a qualitative standpoint as the sanctioning body. At the end of the day, we are all race fans and want to be entertained by what we see.

It quickly became clear that enhancing tyre size, therefore increasing mechanical grip, created a much more stable platform, so much so that drivers could no longer succeed at the 'bump and run'. This technique is integral to short track racing, wherein the only way to pass a car in front is to upset the lead car on corner entry or apex to move them off the preferred racing line. This, of course, leads to high emotions in the cockpit, but happy fans in the grandstand.

Continuing with the mechanical topics, adding larger brakes (arguably appropriately sized, compared to the previous car) greatly improved stopping performance, shortening the braking zones at road courses.

Short tracks are known for close, door-to-door racing, and the drama and excitement that come with that are critical to what makes NASCAR

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Phoenix Raceway in Avondale, AZ was the location chosen to test the new, reduced downforce ST / RC package that was run in 2023

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Road courses use a similar set up to the Intermediate package, but with a shorter spoiler and three strakes removed from the diffuser, reducing downforce by 40 per cent

Compared to the current Next Gen car, the previous Gen 6 design had many features that made it less than optimal for road courses and short tracks, starting with the solid axle, trailing arm-type rear suspension. While great on an oval, the solid axle presented a challenging platform to manage under braking, leading to many mistakes by drivers asking too much of their cars.

The smaller, 15in diameter wheels and tyres had two effects. The first was to limit the brake size dramatically, which reduced overall braking capability. The other was the larger, more compliant sidewall and narrower tread width reducing mechanical grip.

On the powertrain side, the move to a sequential, five-speed transaxle with multiple close ratios in the operating range for the engine offers much better acceleration than the previous four-speed unit. As with the previous generation of gearboxes, NASCAR mandated the final drive ratio in fourth gear and was able to limit shifting down to third gear at most tracks. Why does this matter? That bump and run technique again.

With the ability to downshift to a useable gear in the meat of the engine's power band, a 'bumped' driver can recover quickly from any disruptions they receive from the following car attempting to pass. With the previous gearbox, the unsettled lead car would pay the price with a slower run down the straights toward the next corner, typically leading to a pass.

The Short Track / Road Course configuration… is run at 10 of the 29 different tracks NASCAR visits in it 38-race schedule

Durable body

Finally, the Next Gen car is the first Cup Series vehicle to use all-composite bodywork. Manufactured by Fibreworks Composites, Five Star Bodies and Roush Composites, the Next Gen car features the most durable bodywork the series has ever had. In the Gen 6 era, noses, tails and bonnets [hoods] were composite, with the remainder being hand-formed sheet metal. The metal parts, particularly on the wheel band areas, often sustained damage and could even lead to tyre failure if they came into contact. At minimum, the aerodynamic properties of the car were severely jeopardised.

NASCAR specifies the car configurations each team must use, depending on the track type. These are currently split into three separate packages: Intermediate, Superspeedway, and Short Track / Road Course (ST / RC). The Intermediate race package is run at the majority of tracks, consisting of a specified set of splitter stuffers, engine panel strakes, a four-inch spoiler and a full set of strakes in the diffuser. The power level for the Intermediate package is approximately 700bhp.

The Superspeedway package, run at Daytona, Talladega and Atlanta, features higher downforce and drag via shortened splitter stuffers, a seven-inch spoiler and horsepower reduced to around 520bhp.

Finally, the Short Track / Road Course configuration uses the same splitter stuffers as the Intermediate package, but a 2¼in spoiler and the three central strakes removed from the diffuser. Power is the same as the Intermediate package, but downforce is down by approximately 40 per cent. This set up is run at 10 of the 29 different tracks that NASCAR visits in its 38-race schedule.

Test programme

NASCAR engaged in a testing programme, starting in early 2023, to work on all the elements of the Short Track / Road Course package. Phoenix Raceway in Avondale, Arizona was the site of the first test, and the sport's sanctioning body evaluated a reduced downforce package, with some positive feedback leading to the creation of the current ST / RC package, which was raced throughout the 2023 season.

The solution to improving fan engagement with the racing on NASCAR's short tracks and road courses is the so-called Up / Down splitter, seen here installed on the aero test car at Windshear

In the meantime, Goodyear continued to develop its Next Gen tyres to be softer and enhance tyre degradation (falloff in NASCAR parlance).

Round two of the test programme occurred in late July, with a two-day test following the Richmond race. Originally scheduled for the much faster New Hampshire Motor Speedway, that date was scrubbed due to adverse weather conditions. In the period between the Phoenix and Richmond tests, the aero group at NASCAR R&D worked diligently on developing an aerodynamic package that lost less downforce when in traffic, with the dreaded aero push considered a contributing factor.

Computational Fluid Dynamics (CFD) was used to study both single car and drafting scenarios. The ultimate solution, dubbed the Up / Down Splitter, featured a lift generating centre section and downforce-generating outer sections. The idea being that the central wake behind a lead car near the ground would diminish the lifting section and generate downforce.

Goodyear also brought a multitude of tyre options to the test with the goal of enhancing tyre degradation. Ultimately, thicker tread gauge tyres were found to be a dramatic gain for the test drivers to move around each other and make passes.

Inconclusive result

In CFD, the results were dramatic, and showed a 90 per cent improvement in aerodynamic loss, but the results on track were less convincing. Drivers commented that they couldn't really tell a difference, which was baffling initially, but a comprehensive post-test review revealed several reasons why this may have been the case.

The first is that Richmond has some of the slowest apex speeds of any NASCAR track, with mid-corner speeds in the 80mph range (this would not have been an issue at the original target location of the much faster New Hampshire Motor Speedway).

The next factor believed to have influenced the result is that Richmond is a very abrasive track, making tyre condition a critical factor, even after a single lap, which is not an ideal test bed for evaluating changes, but lesson learned.

Finally, driver behaviour at tests was identified through video as a contributing factor. Drivers naturally tend to be more courteous at tests than in a race environment, where points and money are on the line. This leads to drivers leaving room for their peers and not blocking the trailing car as they normally would. This better explains why the benefits touted by CFD for a trailing car were rarely, if ever, seen during the test since, as you would expect, the majority of the benefit occurs when the trailing car is directly in line with the lead car.

The current iteration [of the Up / Down Splitter] offers a massive 96 per cent improvement in total downforce loss, resulting in single digit losses in the worst positions for the trailing car

Post-Richmond, NASCAR went back to the drawing board and studied the aerodynamics of the Up / Down Splitter even further, finding enhanced single car and traffic gains. The current iteration offers a massive 96 per cent improvement in total downforce loss, resulting in single digit losses in the worst positions for the trailing car.

The aero team also focused on the diffuser, and whether its performance could be similarly improved. A greatly simplified

Next Gen development car undergoing testing at Windshear. Observant readers will note this was also the Garage 56 test vehicle

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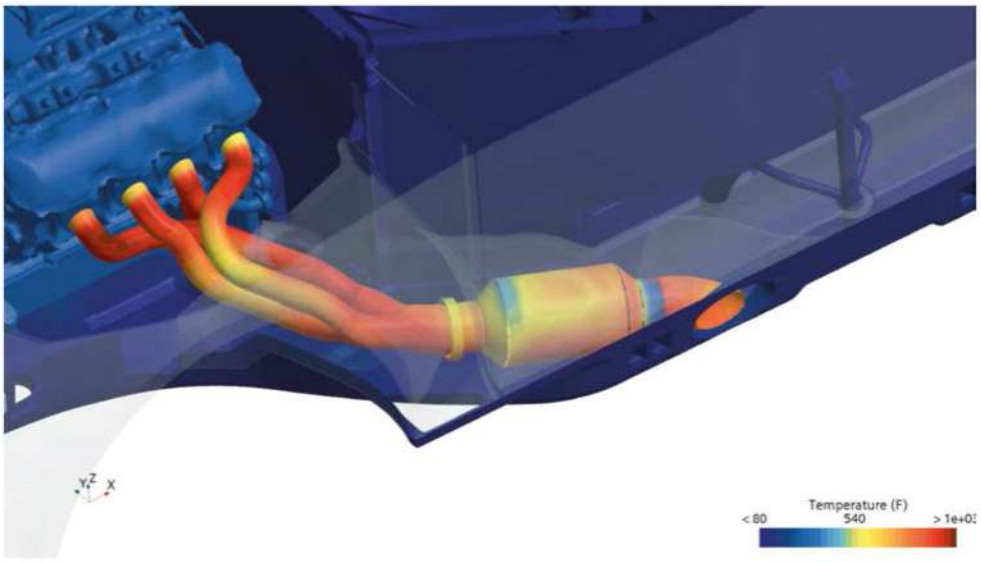
NASCAR runs in the wet with a package that includes wipers, rain lights and flaps, along with appropriate Goodyear tyres. This package was available for 2023, on ovals as well as road courses

version with improved traffic performance was tested and shown to eliminate the benefit of running the car with a high nose and low diffuser height. That, in turn, led to teams chasing to run the rear of their cars as low as possible, and to the rather expensive diffusers being sacrificed in nearly every race.

The revised aero package was evaluated at Windshear's wind tunnel in late October, with the results correlating well to CFD.

At time of writing, the team was preparing for a two-day track test that would take six cars to Phoenix during the first week of December. With a packed test schedule, teams would evaluate aerodynamic, tyre, gear ratio, brake and suspension changes in an effort to improve the short track package. This comprehensive test was to involve changes that touched nearly every area of the car.



Thermal CFD simulation of the revised LA / Chicago silencer (muffler) that will improve cockpit conditions for drivers at those tracks

Sounds of silence

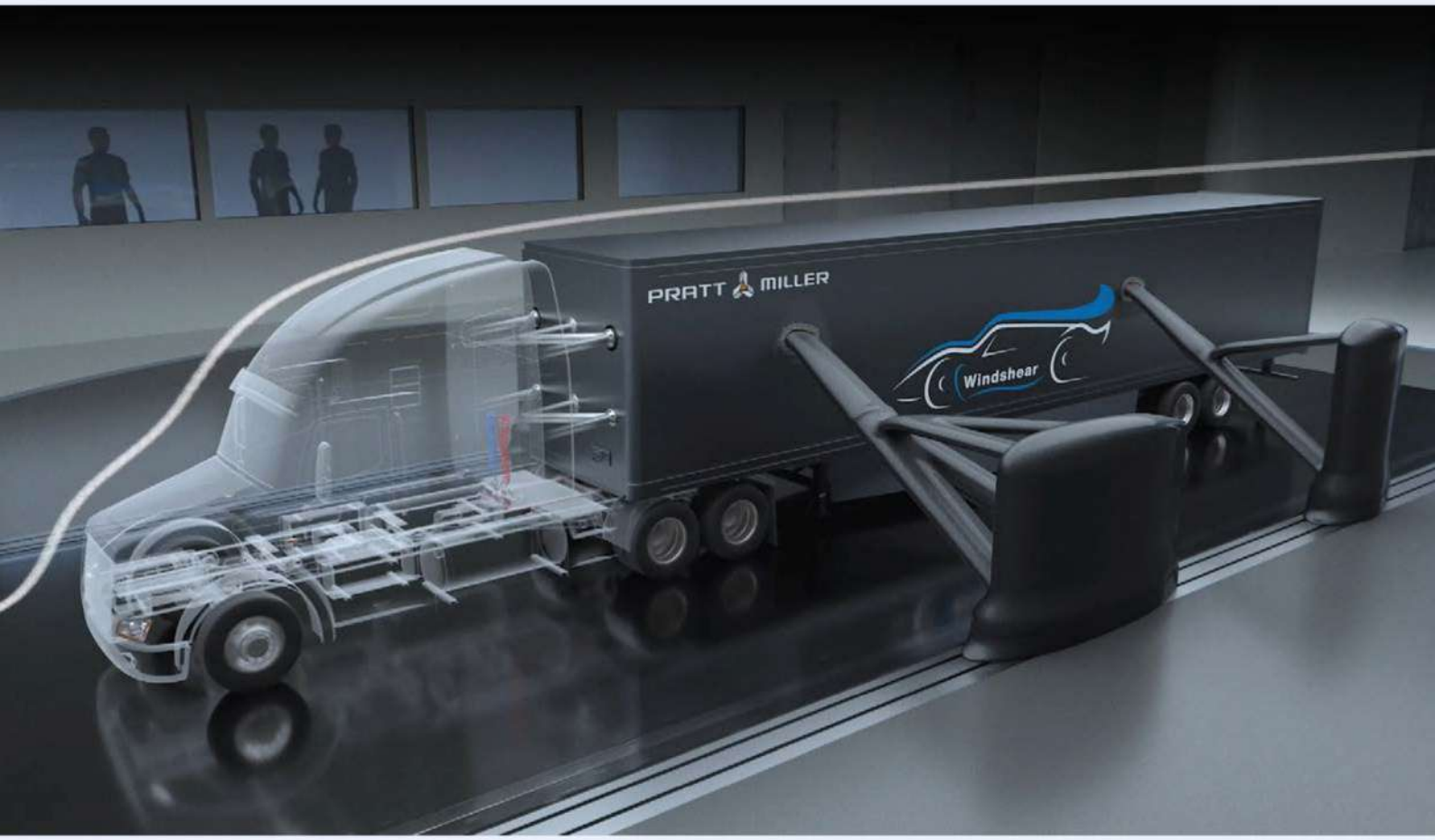
One additional item to be tested in Phoenix was a revised silencer [muffler] that will be used at the Clash at Los Angeles Memorial Coliseum and the Chicago Street Race. The new unit, built by Next Gen supplier, ProFab, will feature a shorter design that utilises the normal forward exhaust exit. In this past season, the silencer used was too long to use the front exhaust exit and forced a return to the rear exit that was initially used in early Next Gen development. This created adverse conditions in the cockpit due to conduction through the steel tube frame chassis. To its credit, ProFab was able to match the decibel reduction of the much longer unit with their revised design, with a minimal impact on power output.

On the aero side, the revised silencer presented an opportunity to re-visit our thermal CFD modelling and upgrade it to include conduction and radiation, as these were believed to be much greater contributors to the resulting cockpit conditions (previously, only convection had been modelled).

Improvements to the cooling of the header and silencer area, along with revised close-out panels to accommodate the larger diameter unit, can look to eliminate the temperature increase observed with the current configuration. If successful, the changes will be evaluated for the non-silencer configuration as well.

In closing, it looks to be a busy off season for NASCAR and the teams. The results of the Phoenix test will inform which direction NASCAR heads with the Short Track / Road Course package and, hopefully, yield positive directions in the areas being investigated.

Regardless of the outcome, NASCAR will continue to work to make every race event and track as good as it can be for fans in the grandstands and across the world watching the series on television.



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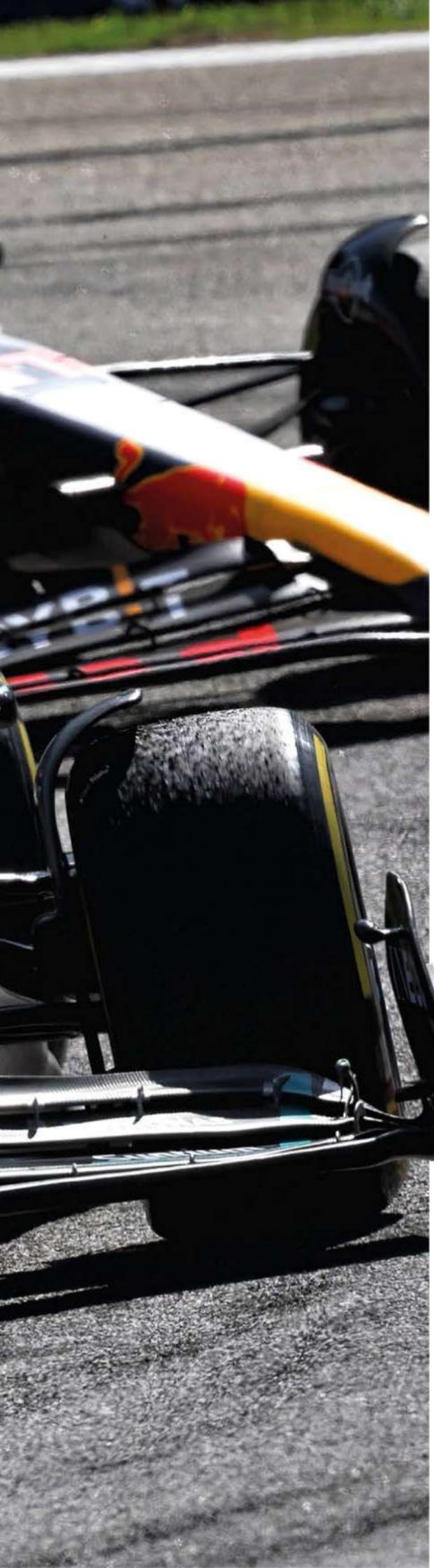


Fighting back... cautiously

After eight years as F1's top constructor, Mercedes was knocked abruptly off its perch after the 2022 rule changes. Technical director, James Allison, explains how the team is trying to revert to its winning ways

By JOE SAWARD

Mercedes continued to struggle with its return to form during this year's Formula 1 World Championship as it continued to pursue the 'zero-sidepod' philosophy that set it apart from its competitors in 2022, but not necessarily in a good way.

The team has won just one grand prix, in Brazil in 2022, over the last two years and has a long way to go to catch up with Red Bull, the team which halted Mercedes' run of eight Constructors' titles.

The UK-based team hoped the 2023 season would see it awaken from last year's nightmare and regain performance compared to the opposition with its new W14, but it was more of the same as Red Bull again accelerated away in dominant fashion, leaving Mercedes in a battle with Ferrari for second place in the championship standings.

'Over the course of that [2022], we developed a car that had plenty of downforce near the ground that, it turned out, we couldn't use because of the porpoising that we did not see coming'

James Allison, technical director at Mercedes F1

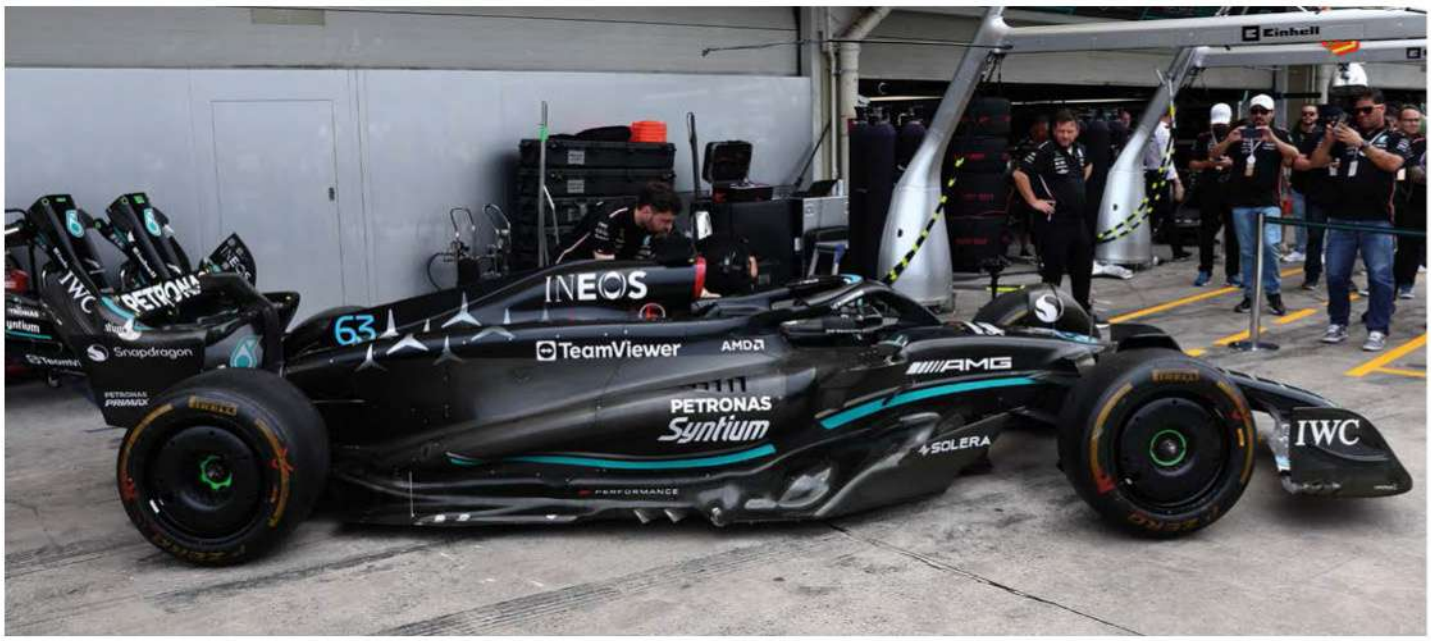
The W14's development and competitive lifespan played out during a time of adjustment among the staff at Mercedes' Brackley headquarters. The F1 teams of today are so large that it is very difficult to blame any individual when things go wrong, but the leadership must ultimately be prepared to take the blame for decisions made.

Musical chairs

What is remarkable about Mercedes is that rather than very public 'executions', as so often happens in F1 under such circumstances, the team's technical director, Mike Elliott, concluded he was not the person best suited to the role he was in, and that it was better to hand that position back to the previous incumbent, James Allison.

The two had conversations along these lines and determined that Elliott would be better focusing on medium and long-term questions as chief technical officer, while Allison would be more of a play-by-play technical director at races. The change was announced in April this year, after an underwhelming start to the season for the team's two drivers, George Russell and Lewis Hamilton.

'Mike's assessment was – and the introspection is really admirable – that with James we have a gladiator on the field and the troops are going to go through the fire for him, and with him,' team boss, Toto Wolff, explained after the news broke.



The highlight of Mercedes' 2022 season was winning the Brazilian GP at São Paolo, at which point the team turned its attention to the new season's car, the W14, but it was not out of the woods yet

Making the situation even more unusual was that Allison would report to Elliott, rather than the other way round, a decision that would be astonishing to many of the top F1 engineers who have well-developed egos and would struggle to accept such a dynamic. The move was a very graphic illustration of the kind of relationships that have made the Mercedes team so successful, yet so different, in the past.

When Allison became CTO in 2021, he argued that 'people have a shelf life in senior roles in this sport' and said he had made the decision to step away 'to pass on the baton at the right time for the organisation and myself.'

Reinvigorated by his time away, Allison was keen to get back onto the battlefield.

Before the Monaco upgrade package, the revised floor car, still with 'zero-sidepod', had shows of speed but remained inconsistent

The hot topic

The 2022 Formula 1 regulations sought to improve the aerodynamic wake behind the cars, allowing them to follow more easily, with a view to improving the racing spectacle. By its own admission, Mercedes felt that its competitors stayed where they were in terms of grid position, and that it was the only one to be badly affected. The platform control of the W13 clearly didn't work as well as hoped, and the Mercedes, like others in the field, suffered dramatically from the porpoising effect.

So badly were the cars bouncing that the team's drivers were struggling with back pain after races. The issue of who was to blame become a very hot topic. Was it the fault of the regulations that allowed such cars to be designed, or the fault of the teams, not all of whom had cars that suffered similarly from the porpoising phenomenon? Ultimately, the FIA stepped in with regulation changes for the 2023 season that raised the ride height of the cars by 15mm to try and solve the issue.

'It was a problem of having too much downforce too near the ground, in a way that produced an aerodynamic instability that was very difficult to understand,' says Allison.

'It took us a while to get rid of it. Over the course of that first year, we developed a car that had plenty of downforce near the ground that, it turned out, we couldn't use because of the porpoising that we did not see coming.

'The downforce would drop away quite quickly when we raised the car. A bit later in the year, we fixed the porpoising [with] some changes to the floor geometry, but we were left with a car that did not have as much downforce near the ground as it used to have. It didn't porpoise though.'

The result on track, however, was the W13 was clearly inconsistent. It was capable of a decent showing at some circuits, but far less competitive as soon as the rear ride height needed to be raised. It could be strong at Barcelona, for example, but then, in Allison's words, 'lousy' at Monaco the following week.

The rest of the 2022 season was spent expanding the car's range of downforce, and looking for more at higher rear ride heights.

In the summer of 2022, as the teams were finalising their car designs for the following season, the FIA announced that ride heights would be raised. This measure, introduced to stop the grid-wide porpoising problem, had a huge impact on each of the teams.

'We went into the new year having won a race in Brazil and having definitely made the car quicker,' Allison says. 'But then we had the rules changed on us quite late in the day to allow cars that would hopefully bounce less. There was a big debate internally about whether we should cash in that 15mm, drop the car down and operate in a window that is 15mm smaller because the cars will be inherently less bouncy. Or should we do more of what did us well over the course of the year, which was to force ourselves to keep looking for downforce high up, where it was difficult to find.'

The upgrade package that arrived for Monaco saw the team move away from its zero-sidepod design to a more conventional concept. Changes were also made to the front suspension and floor…

…which was unceremoniously revealed to all when Hamilton crashed in practice and the car was hoisted skyward off the track

While other teams made use of their sidepods aerodynamically, with deep channels to guide the air, Mercedes chose not to as it sought to minimise drag with an innovative design… its so-called 'zero-sidepod' approach on the W14

The debate over which approach to adopt raged internally for a while as Mercedes considered how to best get back into a winning position. It ended up leaning towards a more cautious methodology for the W14, but that didn't necessarily yield the silver bullet the team was after.

'[The attitude was] let's keep trying to find downforce where it is hard and, if it turns out that we have been too cautious, we will [regret it],' Allison recalls. 'But we will then spend the months that follow working quickly to recover, as opposed to having the opposite problem, which is much harder to cope with.

'If, on the other hand, we are lucky and others cash in the 15mm, without tools that prove that everything will be fine, they will all bounce like crazy. We will then be the smart ones for having taken the cautious approach.

'As it turned out, we were too cautious. It was possible to cash in the 15mm, and we would have been better off placing our chips on that part of the roulette wheel. We would have got to the performance we are at now, only much sooner.'

While other teams made use of their sidepods aerodynamically, with deep channels to guide the air, Mercedes chose to minimise drag with an innovative design. It continued its so-called 'zero-sidepod' approach on the W14 but, at the opening race in Bahrain, there was a half-second gap to the front of the grid. That forced Mercedes into a rapid re-think and a comprehensive upgrade was in place by the Monaco Grand Prix in May.

Mid-season upgrade

This first big upgrade was originally due for round six at Imola, but flooding in Emilia-Romagna meant that race was cancelled, and the revised cars appeared on the streets of Monaco instead. The sidepods were different, moving towards a more conventional concept and away from the W13's narrow vertical inlets. There were also changes to the floor design and front suspension.

Results-wise, little changed, as Hamilton and Russell finished fourth and fifth respectively, even though the former clocked the fastest lap. Notably, an accident for Hamilton during Free Practice 3 gave Mercedes' rivals the chance to see its floor design, since stranded F1 cars at Monaco are lifted high above the ground on cranes rather than brought back on flatbed trucks.

'The lap time that came with the Monaco update was not remotely from the things that were visually different, apart from the anti-dive wishbones,' Allison explains. 'The change to the sidepod fronts were a case of let's just not have that as a thing to worry about for the future.

'The decision to go to that new sidepod front probably took about two tenths of a second off the update package. But at least from that point forward we knew we did not have to fret about it. So, after a pretty torrid 14 months, we could just

take that variant off the table, even though that particular change on that particular day was slower than what preceded it.'

Back on pole

Better things were to come the following weekend at Barcelona, where both Mercedes drivers reached the podium behind the Red Bull RB19 of Max Verstappen. Hamilton then took the W14's first pole position, and the team's first in 12 months, at the Hungaroring. According to Allison, the main areas of improvement that yielded lap time gains were situated underneath the car, along with the rear brake drums, brake ducts and front wing.

'The conceptual change was all about undoing the conservative decision about ride heights,' he adds. 'It is nevertheless true that along the way, as we sought downforce in a different part of the ride height map, you get different geometry under the car as a result.'

Mercedes brought a further update to the Belgian GP, just before F1's summer break. The height of the sidepod inlet was increased to improve radiator and engine cooling, and the rest of the sidepod design re-shaped in accordance. The floor edges were also modified to extract more local load from the vortex generators and improve the quality of airflow to the diffuser.

Mercedes' final update came six races later in Austin where the W14s arrived with a new floor, featuring a raised leading edge to enhance rear downforce. It served as an experiment for design directions ahead of the 2024 season.

Hamilton then went on to finish second in the United States GP, within sight of Verstappen, but his car was later disqualified for excessive skid block wear.

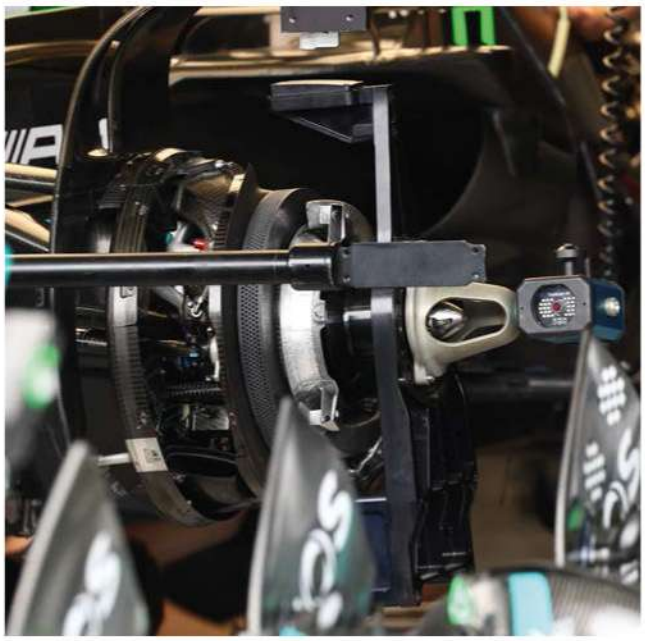
Hunting for treasure

Allison reckons that Mercedes' fight back from a difficult start to the new regulations was not restricted by the need to stay within F1's budget cap, and is confident the team has the know-how at its factory to return to a title-winning position.

'It is not the cap that is making it that way,' Allison asserts. 'We who are chasing just need to chase a bit harder… and they [Red Bull] need to become a bit complacent.'

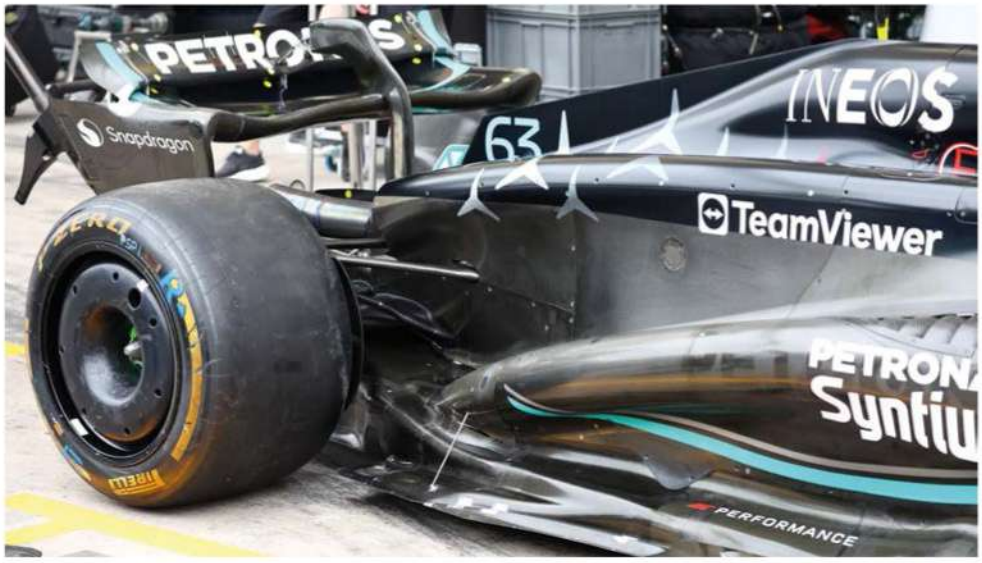
The fact that all the top teams, apart from Red Bull, seem to have stumbled is curious, but Allison sees this as the reason behind the Milton Keynes-based outfit's domination. He also doesn't blame losing key people to rivals for the problems (Red Bull hired several top Mercedes engineers to staff its new powertrain division in the wake of Honda's temporary exit from F1).

'It does have an impact, for sure,' says Allison, 'but I wouldn't lay the difficulty we



'The lap time that came with the Monaco update was not remotely from the things that were visually different, apart from the anti-dive wishbones'

Monaco upgrade included lifting the top wishbone forward leg inboard pick-up for improved positioning of the wishbone wake, enhancing flow into the new sidepod



Further improvements were made to the W14's sidepods and floor as the 2023 season progressed. The height of the sidepod inlet was raised to aid cooling and the floor edges modified to better exploit the vortex generators and improve airflow to the diffuser

The final 2023 update came in Austin for the US Grand Prix where a new floor with a raised leading edge was used to try and further enhance rear downforce. The car proved quick and Hamilton finished second, but was later disqualified for excessive skid block wear

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have had at that door. We placed value on the wrong things, and so you get a thing that accurately reflects what you placed value on.

'I think that whether by good fortune or enormous skill, the quick cars are the ones that have conceptual strength. The execution of that concept will be more or less elegantly done depending on the quality of your drawing office staff, but what makes the thing work or not is the underlying things you value.

'To use a crude analogy: where is the treasure buried? The efficiency of your factory will dig it out of the ground for you, but only if you are looking in the right place.'

Some in the F1 paddock argue that the complexity of the current cars is really the underlying problem, but Allison is not convinced by that supposition. Mercedes has placed substantial effort on creating harmony between the car's aerodynamic performance and its mechanical ride.

'When you are designing the car, the people who are making the compromise decisions between the aerodynamic and mechanical behaviour have to pay a bit more heed to the needs of the car mechanically than they did in the past,' Allison suggests. 'Back then, you could just say aero is king and the suspension guys would make it work. There is more of an intimate relationship now than there was.

'We also have a much better handle on how you get the aero platform and the spring platform to be happier bedfellows. That is the main challenge.'

Going into 2024, Allison says the team has a better understanding of the relationship between the car's aerodynamic and mechanical behaviour, having learnt a huge amount in the last two seasons. But have they learnt enough to win?

A truculent thing

Allison readily admits he is not a big fan of having the cars running so close to the ground. Although a lower car generates more downforce, there is a point where drawbacks start to creep in.

'You don't want it to just magnet itself to the ground at the end of the straights because that is just generating drag for you,' he says. 'The end-of-straight downforce punishes you in the slow corners. So there comes a point at which you cannot support the end-of-straight load without hurting yourself in the slow speed stuff. I personally don't think it's a good thing to have cars with that much space to the ground.'

Allison acknowledges that Mercedes tuned out some of its drivers' complaints as it put all hands on deck to resolve its porpoising issues. For example, Hamilton was dissatisfied with his seating position because it restricted his view of corner apexes, while neither driver was happy about the instability of the car on turn-in.

'When we were utterly stuck in the bouncing hell, all we could do was fix that because it was the number one, two and three problem,' says Allison. 'We were not good enough at listening to the fact that they were telling us something else in parallel.

'The actual seating position itself was not giving rise to a perceptual issue that made it hard for [Hamilton] to detect how to handle the car. Possibly if he was sitting exactly where he wanted, he might be able to drive a truculent thing with slightly more precision.

'But the issue there is to get rid of the truculent thing, not optimise his seating position to handle something that isn't good. Our focus has been on making it less horrid, and I would say that the Austin upgrade was a mild step forward in that regard. With a bit of luck, next year's car will bring a load more.'

'Our focus has been on making it less horrid, and I would say that the Austin upgrade was a mild step forward in that regard. With a bit of luck, next year's car will bring a load more'

Elliott announced just before the Brazilian GP in November that he had decided to stand down from his CTO role at Mercedes. It marked the end of an 11-year journey with the team and 23 years of 'working flat-out in this sport' as a leading aerodynamicist and technical lead with several organisations. Since becoming Mercedes' CTO, Elliott had been working to build foundations for the future and, when he felt that was done, he decided it was time for a break.

'Although the last two seasons have not seen us winning races in the manner we aspire to, they have tested us in many other ways,' he said in the announcement. 'It has forced us to question our fundamental assumptions about how we deliver performance. I have enjoyed developing the technical strategy that we hope can provide the foundations of the team's next cycle of success.'

It remains to be seen if that next cycle will materialise as early as 2024, or if Mercedes will spend another season among the bridesmaids as it waits to end Red Bull's second wave of domination.

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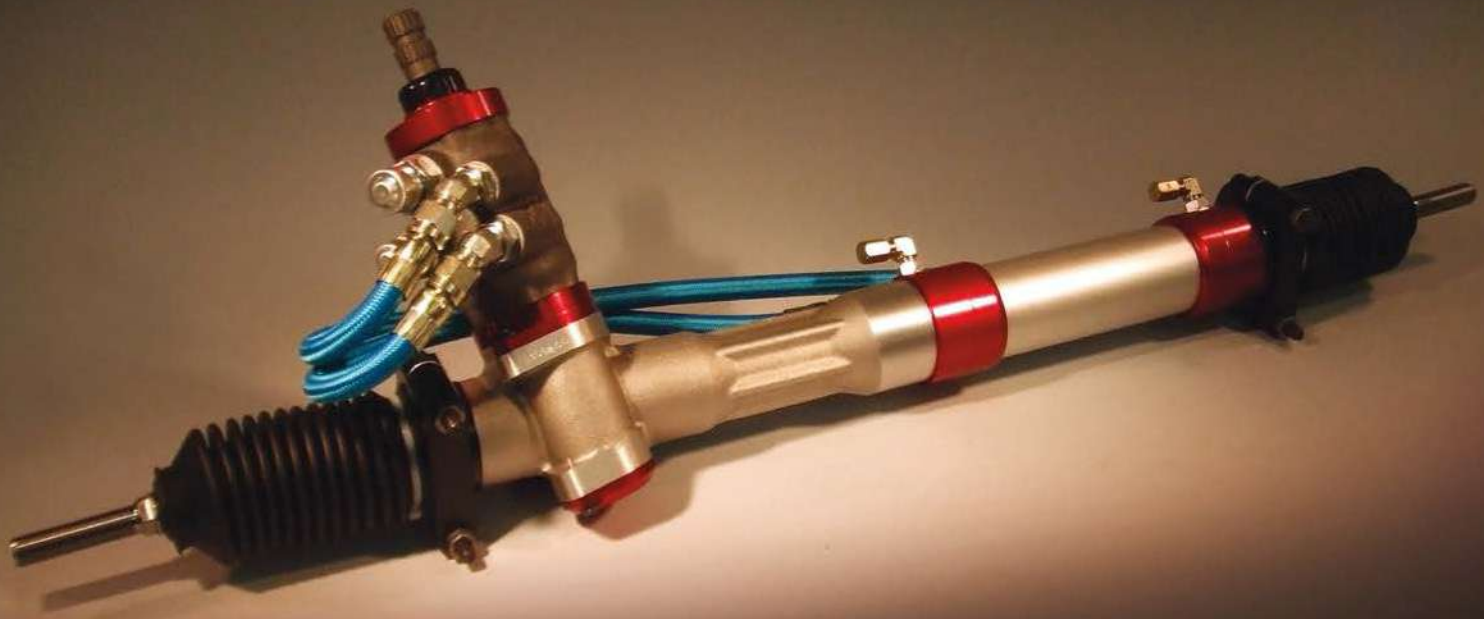

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Were it not for a controversial last-minute change to the BoP for Le Mans that appeared to favour Ferrari, Toyota Gazoo Racing's GR010 hybrid would have had a clean sweep in the 2023 FIA World Endurance Championship. Shown here leading the pack at round two, the Six Hours of Portimão in Portugal

Destination, anywhere

The LMH cars hit the ground running in 2023, but there was still some development that needed to be done to cope with yet more new regulations

By ANDREW COTTON

The 2023 FIA World Endurance Championship was something of a walk over for Toyota, who won every round other than Le Mans, which went the way of Ferrari.

There was controversy throughout, notably around the Balance of Performance system, which changed for Le Mans to ensure closer competition. There was also a new tyre specification from Michelin for this year, and a new category of cars with the arrival of LMDh competitors from Porsche and Cadillac for the first time.

Toyota and Peugeot continued their programmes with updated cars, and faced new challenges from Ferrari in the LMH class. Privateer entries came from Jim Glickenhaus and Colin Kolles, which meant there was the variety that the organisers intended.

However, each of these changes came with challenges for the governing bodies.

Balancing the LMDh cars, which are very different in concept to LMH, became a major topic of conversation. Ferrari's new 499P had speed, but not over a race distance, while the new tyres achieved Michelin's goal, yet tyre warmers were re-introduced as a safety measure at Le Mans.

Loose talk

While the FIA and ACO banned talk of BoP in the paddock, it remained one of the key differentiators on the track. The organisation issued a BoP table for the opening race at Sebring, which, due to its bumpy nature, was considered an outlying track. A second BoP table was then issued for the next three races, at Portimão, Spa and Le Mans, with the proviso that if the LMDh cars needed further adjustment to allow them to race competitively with the LMH cars, a platform change would be implemented.

Toyota dominated the opening races at Sebring, Portimão and Spa, so the ACO and FIA decided to break their rule for Le Mans. They issued an updated BoP table, giving the Toyota more weight and the Ferrari more power, while also balancing the cars within the LMDh category in a bid to have better racing at the centenary edition.

While the FIA and ACO banned talk of Balance of Performance in the paddock, it remained one of the key differentiators on the track

Photos: XPB

It was a decision that, understandably, infuriated Toyota. In the end, the race was not necessarily decided by the new performance balancing measures. Both Toyotas crashed, which cost more time than the electrical maladies that affected the winning Ferrari, but it was clear Toyota had to work harder, which changed the shape of the race.

Tyre warmers

There was further controversy at Le Mans as tyre warmers were re-introduced to the series for that race only. Michelin brought new tyres to cater to the needs of the LMDh and LMH cars, did away with the intermediate tyre to leave only slick and wet options, and then a decision came late to ban tyre warmers.

Many supported the decision to allow the GTE-Am class cars the option to have tyre warmers for the race, mainly because the there were Bronze category drivers on the teams and the tyres were 2022 specification, designed to be warmed before fitted to the car. However, the FIA and ACO eventually decided that all cars, including Hypercars, could run with pre-warmed tyres, but for Le Mans only.

Post Le Mans, the FIA and ACO reverted to their original BoP system, balancing only the potential of the cars, rather than the potential of the overall team, and Toyota won each of the remaining races. Indeed, the final round in Bahrain saw the Japanese team lap almost the entire Hypercar field, including the factory Porsches and Cadillacs, the Peugeots, all but one of the privateer Porsches and one Ferrari. This, despite one Toyota having a torque sensor failure that reduced power for half the race, and the other a clutch failure that cost time at each pit stop.

Toyota dominance

The GR010 was undoubtedly the car of the championship, able to switch on its tyres in all conditions, manage them better than anyone else through the second stint, and exhibit both reliability and speed.

The car went through a major evolution over the winter of 2022, arriving at Sebring with significantly less weight in the rear and better overall balance. For the 2022 season, Toyota had switched from the same size tyres all round to narrower fronts and wider rears, and for the 2023 season optimised the weight distribution accordingly.

The team also changed the gearbox casing for a lighter version, and altered the metallurgy used in the construction of its engine, moving away from the road car base that formed the original power unit for the car.

The team was also able to work on the front suspension, fitting a cockpit-adjustable anti-roll bar to bring it into line with the LMDh cars, and optimising the open front differential that was mandated after Le Mans in 2022.

'The biggest step was at the start of the season,' says Toyota's Hypercar project leader, John Litjens. 'The previous season we went to the different tyre size, but there was still a penalty on our back from being the first on track with the regulations, so we still had a heavy car.

'The other manufacturers came in when we didn't know where the BoP would go, but the biggest work was on weight saving and reliability. Trying to get aero stability and stability for tyre use was important, too.

'During the season you develop car set-up, mainly for consistency on the tyre.'

Performance windows

Bringing the LMH cars into the same performance window as the LMDh cars meant the front-mounted hybrid system had to be somewhat castrated so the car performed more as a two-wheel drive. That explains the open front differential, but the activation speed of the four-wheel drive was also set at 190km/h at most circuits.

That meant the cars were using between six to nine seconds of power delivery at Le Mans, on a 210-second lap. Even then, the electrical hybrid power replaces that from the combustion engine, rather than adds power, and it also cannot be used to extend stint length, so the entire system becomes more of a cornering tool than one for power or fuel efficiency.

'To some extent it might be easier for LMDh because they can use the hybrid from the beginning [of the acceleration phase],' says Litjens of the Porsche and Cadillac, which have the hybrid system on the rear axle only. 'If you have turbo lag, you can boost with hybrid from the beginning.'

Ferrari started strong, setting pole at Sebring with its new 499P LMH but struggled with tyre wear and reliability issues throughout the season, including here at the Six Hours of Spa in Belgium

With the Ferrari given more power, and the Toyota more weight, just ahead of the WEC's flagship race in France, it was almost inevitable the Italian team would be more competitive. The best Toyota ended up crashing trying to play catch up

To underline its dominance, at the final round in Bahrain, the GR010 Hybrid lapped almost the entire Hypercar field, including the factory Porsches, Cadillacs and Peugeots, and all but one of the privateer Porsches. And that was with technical failures on both cars Ferrari.

The GR010 was undoubtedly the car of the championship, able to switch on its tyres in all conditions, manage them better than anyone else through the second stint, and exhibit both reliability and speed

However, Toyota has been running hybrids since it first entered the series in 2012, is financed by its hybrid division in Japan, and so has optimised not only its control systems but also the efficiency of its motors and batteries. It was hardly a surprise then that the team showed such dominance this year.

'The new manufacturers were coming, and people expected them to be at the same level out of the box, but that would be strange,' continues Litjens. 'It could be that one could do it, but not three or four. It is logical that newcomers need more time. It was quite late from their side, which is common, but we have done two years of testing and racing [with this car].'

Sensor failures

Toyota had two failures of a mandatory torque sensor, both on the same car, which finished second in the championship. The first was a failure inside the sensor, at Portimão, where the team had to change the entire driveshaft that housed the sensor.

After that, the regulations were modified slightly so that, if there were a failure, the car could continue with reduced power so as not to gain an advantage, but would not be so penalised by having to stop to change a corner of the car. That rule change served Toyota well in Bahrain where the sensor split open, possibly due to accident damage from first corner contact.

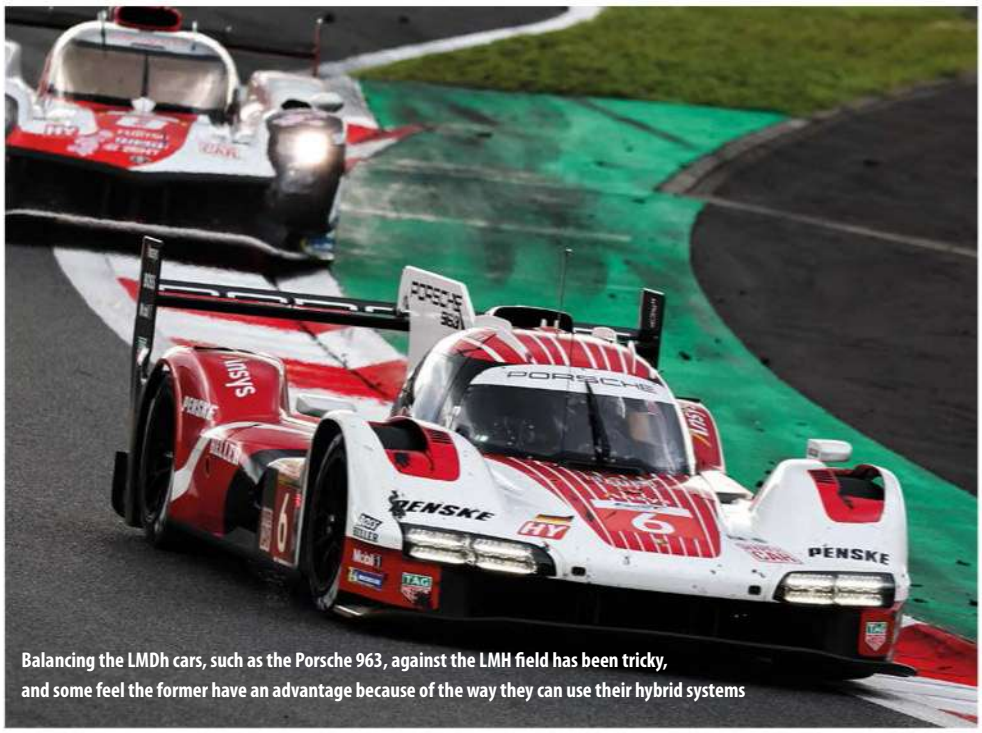
The only other major reliability issue came in Bahrain for the sister car, when a clutch failure meant that it had to re-start from a pit stop using front drive only, trying to get the rear wheels to turn in gear to allow the engine to start.

The team, run by former Michelin tyre engineer, Pascal Vasselon, was good with its tyres and could manage them consistently through a double stint. Tyre allocation was such that a set had to do more than one stint at one point in the race, and this was where Toyota's strength lay.

Hard wearing

Ferrari came into the championship with the 499P already having a reputation for being hard on its tyres from pre-season testing. The Italian team disputes that assertion, saying it just had to learn how to set the car up to run the softer rubber, but it took all season to be able to do so and, even then, it was not clear it had the same options as Toyota.

The 499P started its racing career with a pole position at Sebring and was a regular podium visitor after that, but there were reliability issues at Portimão with the braking system and at Le Mans with the hybrid electrical system, plus some questionable tyre decisions that led to a race-ending accident at Spa.



Balancing the LMDh cars, such as the Porsche 963, against the LMH field has been tricky, and some feel the former have an advantage because of the way they can use their hybrid systems

The car was not without its own controversy, notably around the rear wing. The mid-beam appeared to be in the exhaust flow, the wing adding downforce and the exhaust gas reducing drag, which is something that cannot be balanced in the wind tunnel as the cars are tested with the engine switched off.

According to endurance committee chairman and Ferrari sponsor, Richard Mille, Ferrari had an even more potent Coanda-effect exhaust, though he argued against it being on the car for 2023. Ferrari, however, says the beam is within the rules, and that it firmly expects to retain it next year.

'The first thing we tried to do was to understand the car's strengths and weaknesses,' said Ferdinando Cannizzo, head endurance racecars at Ferrari. 'As long as you are aware of your strength, then you can push it to the maximum, and as well as you are aware of your weaknesses, you try to understand how to minimise the gap or fix them.'

Twin test

Ferrari made the decision to run two cars in testing up to the first race, an expensive way of doing such a thing as the two chassis were under development throughout. However, it meant that if one car stopped running for whatever reason, the other could continue.

'One car was to get mileage and to look at the reliability of the systems, which was important for endurance, while the other was for performance – how the car should be set up for a track layout, weather condition, tyre compound and so on,' says Cannizzo.

The team looked to improve the braking system, suspension set-up, camber settings, dampers and ride height, tyre pressures and electronics to have a quick, reliable car that was able to manage its tyres throughout the six, eight or 24-hour races.

'Power is limited by regulation and we are there. We are good on reaching the torque curve, and the way we are managing the torque control and power control it is almost perfect'

Ferdinando Cannizzo, head of endurance racecars at Ferrari

'Aero-wise, we are pretty happy with the efficiency, but what we would like to look at better is the combination of downforce and mechanical set-up,' says Cannizzo. 'On the aerodynamic side we can do better, but we are limited. There is no limitation on the mechanical side, other than the weight distribution.

'On the power units, we have proven we are at the top level, there is no issue on reliability on the powertrain in the race. Power is limited by regulation and we are there. We are good on reaching the [regulated] torque curve, and the way we are managing the torque control and power control it is almost perfect.'

Ferrari has been vocal in its criticism of the castration of the front hybrid system, with decisions to reduce its potential coming later than the sign off for the 499P, which led to compromise in the design. Cannizzo today describes the hybrid system as, 'very

Michelin's view

Unlike IMSA, the FIA WEC allows for tyre choice by the teams during the races. Michelin nominates which two tyre choices it brings to each race, and teams can run either, or both. They can also mix tyre sets, running harder compounds on the rear and soft on the fronts, or harder compounds on one side or another.

As the LMH cars each have very different requirements, Michelin was clear that it did not want to decide which team would win by selecting only one compound per race.

'There were probably more differences between the Toyota and Ferrari than the average LMH and average LMDh,' says Michelin's director of motorsport activities, Matthieu Bonardel. 'The engineers, the drivers are different, the way the car is designed is different. The one thing that is interesting is that we have learned how things move quickly.

'Ferrari was brand new this year. At the beginning of the year, the car was not optimised, so was tough on tyres, and every time they tried the soft there was degradation, the medium there was graining, so they tried the hard and that was great. They liked the hard so much they used it when it was very cold, but then crashed because there is a limit.

'The reality is that when the hard tyre was hot, it was faster than the rest because of the car. They slowly started to figure out that they could go a lot more using the soft compound, and started to understand what every spec can bring, and are now much better at using them.

'Toyota still has a little advantage, but I see Ferrari capable of moving to a different compound. Maybe Ferrari will overlap more compared to Toyota. That's a natural evolution from the race team, to figure out what to do and what not to do.'

expensive ballast. If you look at Bahrain, if you ask where we use four-wheel drive, the answer is at one point where we corner above 190km/h. That is really frustrating.'

Ferrari was another to retro-fit an adjustable front anti-roll bar, which affected the front suspension design, and the team says it is still learning how to use the system most effectively.

Smaller rubber

However, the bigger change was the mandatory decision for cars entering in 2023 to run with the smaller front tyre.

'It was a huge compromise in the design,' says Cannizzo. 'When we had the 34-34 tyre [same size front and rear] we were very far forward in the weight distribution to make the tyre work at the front. As long as we have the smaller tyres at the front and bigger at the back, we had to move all the mass to the back as much as possible to match the weight distribution target Michelin gave for that specific tyre. It required a high effort and cost.'

The ability to manage the tyre over a stint, and then a double stint, is key to success and Ferrari has not yet bettered Toyota in this regard.

'The car is good with all the compounds,' argues Cannizzo. 'The decision to use one compound or another depends on other factors that are not just tyres. They sometimes are used to overcome other gaps we cannot close, that hopefully give us advantage on strategy for example.

'If we were on the same strategy, we would lose the race because we could just follow them. This is what happened at Spa.

'We are not shy to be aggressive. Sometimes people say we are not good enough, but it is our approach. We want to win, not just to finish. And if we cannot win by being fast every lap, we try to understand how we can cross the finish line first in a different way.'

As BoP is a banned topic in the paddock, teams have learned to dance around the subject while delivering their message. After Ferrari was beaten at Monza, it decided not to say anything to the media at all, a silent protest of sorts against the system. That was not well received, though, so the team improved its line of communication for subsequent races.

'I value the experience that Toyota collected,' says Cannizzo. 'And not just Toyota, but all the colleagues that are here working hard. Nevertheless, I am a racer, and I would like to win on track with all the same potential.'

Peugeot 9X8

The third LMH manufacturer is Peugeot. The team is the only one not to have switched to the narrower front, wider rear as it raced in 2022, and shifting the weight rearwards would require a huge concept change. The 9X8 is the only prototype of modern times not to run a rear wing due to its forward weight bias, generating downforce from the underfloor, and is the only hybrid LMH car not to have won a race this year.

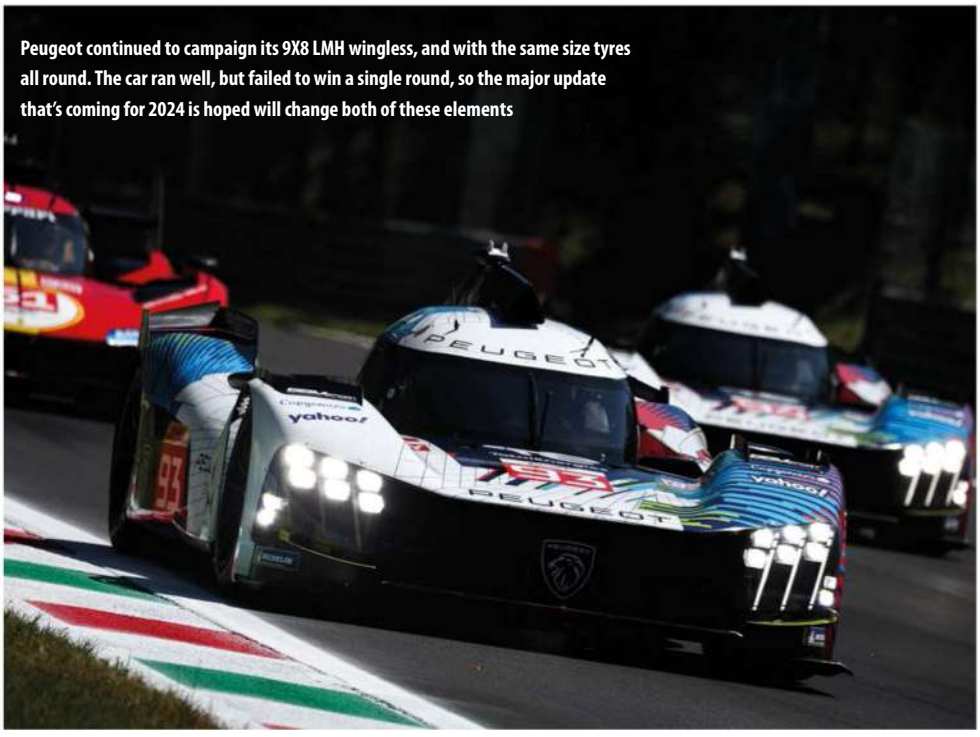
Since Le Mans, the team has performed better, and it is no secret that it has developed a significant upgrade package for next year that includes the tyre size switch and a rear wing, helping the aero balance to shift rearwards.

The issue is that, having requested a large update kit and used its performance jokers to do so, the French team still requires permission from the ACO and FIA to implement all or some of it, and that kit then needs to be tested again in the wind tunnel at Sauber.

This was the first year the 9X8 raced at Le Mans, so the first six months were spent preparing for that race. The focus was on improving reliability, notably around the gearchange mechanism, and the team switched from an electronic system to hydraulic early in the year.

'Starting from Sebring, we brought a small update on the aero kit to try to cure the drag issues we had last year and it did about 70 per cent of the job,' says technical director, Olivier Jansonnie. 'We are pretty much there on top speed, which is a good point, and maybe better since Le Mans following the correction of power on the BoP.'

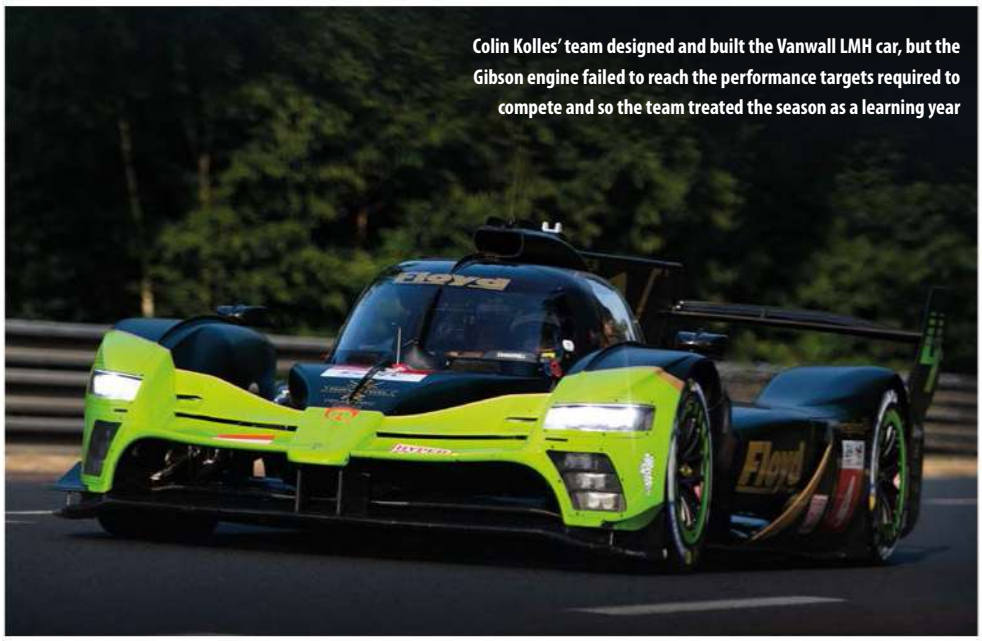
The team worked on the software and mapping of the car, in preparation for next year. Running with better reliability meant testing became more instructive as the car ran for longer.



Peugeot continued to campaign its 9X8 LMH wingless, and with the same size tyres all round. The car ran well, but failed to win a single round, so the major update that's coming for 2024 is hoped will change both of these elements

'This has been a huge development year. We are a race team, a development team and manufacturer of the car. We don't split the team in two, to have pure design and development, and race'

Olivier Jansonnie, technical director at Peugeot



Colin Kolles' team designed and built the Vanwall LMH car, but the Gibson engine failed to reach the performance targets required to compete and so the team treated the season as a learning year

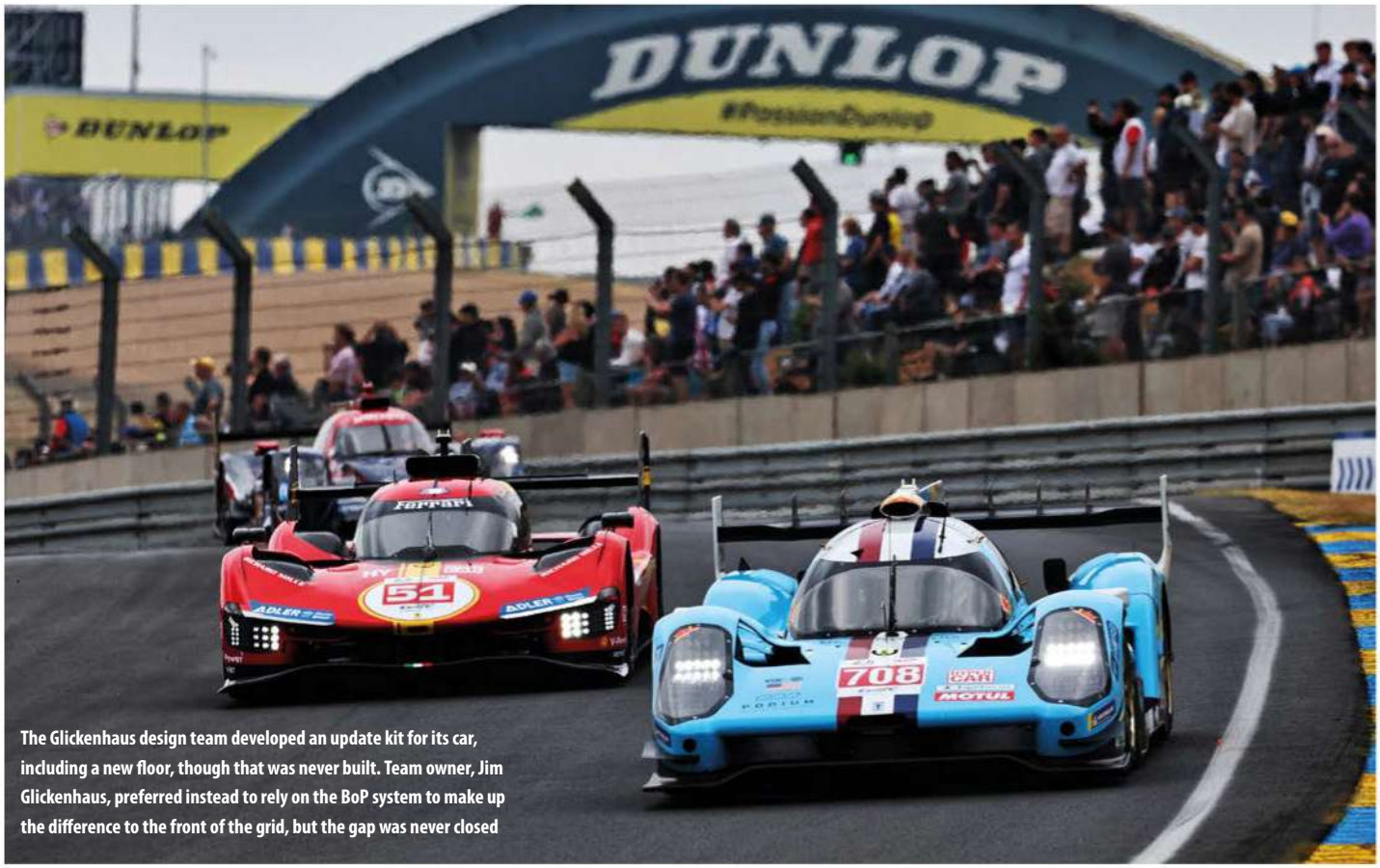
However, the team struggled in winter testing, as Jansonnie explains: 'This was the first year we got rid of the intermediate tyres, which was an issue for teams testing in Europe in the winter.

'It is something you can manage if you can heat the tyres, just having a slick or a wet, but not having an intermediate tyre and not warming the tyres was not the best combination.'

It seems a moot point given the other issues the car faced this year, but tyre choice was still an important factor.

'I don't think our car prefers something harder, but we are less experienced and there are many tracks this year when the optimum potential tyre was not clear,' says Jansonnie. 'Portimão it wasn't super clear, and Spa it wasn't, neither was Fuji. We are the only ones still wondering how it works!'

For the team, the year has been another one of learning. It has improved in terms of strategy, pit stops and preparation, but there is still a long way to go to get to the front of the grid. 'The list [of updates] is long, but generally with the homologation system, 80 per cent of the car is carry over,' says Jansonnie of the upgrade kit that was requested. 'This has been a huge development year. We are a race team, a development team and manufacturer of the car. We don't split the team in two, to have pure design and development, and race. The guys that are here are also developing the car. We have to focus on the race, and we did the best we could this weekend, and we need to keep up with that because that's the job. But we also have to look at the 2024 car because that is more important for us now.'



The Glickenhaus design team developed an update kit for its car, including a new floor, though that was never built. Team owner, Jim Glickenhaus, preferred instead to rely on the BoP system to make up the difference to the front of the grid, but the gap was never closed

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THE POWER BEHIND YOUR SUCCESS

Goodyears to come

The WEC will introduce GT3 to its ranks next year with an all-new tyre. Racecar *investigates what is needed*

By **ANDREW COTTON**

After beating Michelin, and others, to the tyre contract, Goodyear spent this year on a development programme and the first slick is now signed off in readiness for the '24 season

There will be a few big changes on the grid for the FIA World Endurance Championship for 2024, one of which will be the lack of LMP2 cars for the first time since the series was launched in 2012. That is a loss for the series, but also posed a threat to the participation of tyre manufacturer Goodyear, the sole supplier to the category.

However, the American rubber giant made the successful transition from LMP2 to GT3 for next year, having seen off some stiff opposition, notably from Michelin, which supplies the Hypercar field, to win the contract to supply the GT3 field in the series. Having done so, the company undertook a complete development programme that finished at the tail end of 2023 with final sign off of its first slick tyre, with a second to be introduced later in 2024.

Building a tyre to the specification set by the FIA and the ACO is not for the faint of heart. Not only must the tyre work on the abrasive grand prix circuits that make up the majority of the series, it must also work on the low grip Le Mans surface. It must work in all temperature ranges, be able to double stint at each GP track and triple at Le Mans, all while working with a fast start up due to the lack of tyre warmers.

If that was not a hard enough target, the plan is to reduce the tyre allocation to the teams in the future, while Goodyear's own target is to increase the amount of sustainable material used in the tyre, doubling the content as soon as it can.

GT3 experience

Although Goodyear does not supply GT3 tyres to a championship, this is not the first GT racing tyre the company has produced. As Dunlop, it supplied the GTE-spec Aston Martins in a tyre war with Michelin that led to the FIA going to a sole supplier to make the BoP easier. Since then, it has developed its GT3 product at the Nürburgring, a race where competition between tyre brands still exists.

Using this experience, plus that of the tyre development for GM's Garage 56 entry at Le Mans, Goodyear's team in the UK, Germany and the US started from the ground up developing a tyre that met the FIA's needs.

Using the latest simulation technology in the early development phase, Goodyear produced a tyre that will, from race one, be able to at least double stint on all circuits

Using the latest simulation technology in the early development phase, Goodyear produced a tyre that will, from race one, be able to at least double stint on all circuits.

That's a challenge, but even more is that the first race is in Qatar, a circuit that already ran into problems with the Formula 1 grand prix earlier this year due to its kerb specification for the 'bikes that also race there, and it has been re-surfaced recently. Also new to the schedule is São Paolo, again a re-surfaced track, but one with specific tyre needs, as cars have a heavy left / right imbalance in terms of wear there.

Goodyear will be able to bring only one specification of tyre to each round of the WEC, meaning this one tyre will need to withstand the high temperature, high degradation circuits such as Qatar and Bahrain, while also the cold temperatures that typically greet the series at Spa and overnight at Le Mans.

Operating window

Developing tyres with a wide operating window is nothing new to the company. It did the same in LMP2 and in the British Touring Car Championship, where temperature variations can be wild during a season.

'We have looked at new constructions and then a compound range to go with it,' says endurance racing programme manager, Mike McGregor. 'We have done various testing

Photos: Jakob Ebery

Complicating development is the fact GT3 has front, mid and rear-engined cars competing together, with different aero packages. There are also some new arrivals such as the Ford Mustang GT3

cycles, at Paul Ricard, Road America and COTA. There was also a long test at Aragon, running through the day and night, all looking at the target of double stints.'

One of the complications of the GT3 tyre is that, unlike LMP2, which turned into a one-make class of V8-powered ORECAs, the production-based class sees front, mid and rear-engine cars with very different handling characteristics all lining up together. Learning how to set the cars up for running on the new tyre is also a process that must be finalised ahead of the 2024 season.

'We have tested with various manufacturers, with different configurations and weight distributions, as well as the different aero packages [for cars such as the Lexus, which is bringing updates, or new cars, for next year],' says McGregor.
'It is much more complex than GTE in terms of trying to formulate a tyre that suits because of the variations of cars.'

For the GT3 car manufacturers that want to race in a varied programme, they must prepare their cars for each of the tyre brands. Michelin supplies to IMSA for GT3, Pirelli to the GT World Challenge, and Goodyear to the WEC. Each tyre requires its own approach.

'It's a different mentality and logic, you can't just take a tyre off the shelf and put it on the car and it works, and suits that car,' confirms McGregor. 'There's some work in there, and that is why we started testing with a lot of the manufacturers, learning how our tyres need to be run and how they need to be managed to ensure they can get the right performance level for a double stint.

'People that may be used to other championships cannot just turn up and bolt a set on and off they go. Having said that, even at the starting point in Portimão, the feedback from manufacturers that hadn't driven on our tyres before, or hadn't been part of the development phase, was complimentary of how good the driveability was, how good the grip level was and how consistent the level of performance was in the tyre package.'

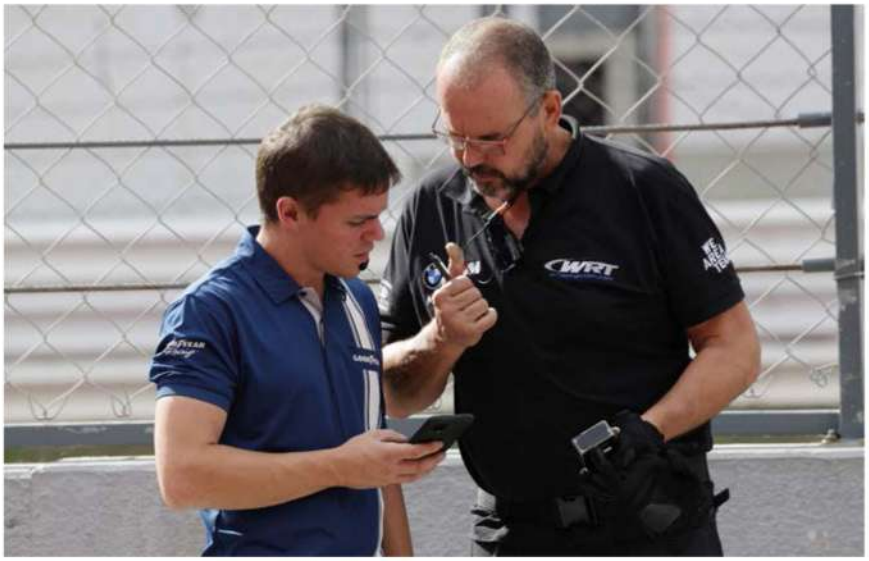
'It is much more complex than GTE in terms of trying to get a tyre that suits because of the variations of cars'

Mike McGregor, Goodyear endurance racing programme manager

Pushing boundaries

Running multiple stints on the same set of tyres is becoming more commonplace in the WEC, although the majority of GT3 series are still running single stints, even in endurance races. Goodyear reached the point that it could run five stints on the same set of tyres at Le Mans with its LMP2 product and hopes that will also happen in GT3 in the near future.

'It's a testament to endurance racing,' says McGregor. 'It's a testament to what the ACO and FIA have set out from the beginning, of really pushing the boundaries and limits of what these tyres can do.'



Goodyear designers in the UK, Germany and the US collaborated on the tyre, which was tested in America and Europe

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Goodyear signed off the development of its initial tyre spec at Paul Ricard in August 2023. The French track, often used for tyre testing, is famously aggressive on rubber and so is considered to be a perfect surface for understanding the majority of grand prix tracks used in the WEC. Equally famously, the surface is much harder than the street section of the Le Mans track, where grip levels are appreciably lower.

Having such a range of circuits is the reason why Michelin produced multiple options for its Hypercar tyre, and why Goodyear will do the same. The second option for the slick will be available mid-season, but Goodyear, and Goodyear alone, will choose which of the two options it brings to each round of the championship.

'We ran the final version of the first edition of the slick at Portimão following the last round of the European Le Mans Series,' says McGregor. 'We still have to work on the wets, and [at time of writing] we are doing some finishing touches to that right now.

'The wet is based more on a lot of our learnings from the Nürburgring, which is obviously more focused on GT3 in terms of construction. That spec will be released shortly to be available to the customers.'

'It is much more about what we are developing for the future in production cars. If you take your road car and drive from the UK to the Nürburgring, do some laps… you need one tyre that can do it, and that is similar to what we are doing with these race tyres'

Starting cool

One of the key differences for the tyre next year is that it will be designed to work without tyre warmers. That was one of the reasons why the GTE-Am teams, running Michelins, didn't receive a new tyre for the 2023 season, as a new spec would only have been for one year. While Michelin was the main architect of the move away from warmers for the championship as a whole, Goodyear was the manufacturer that fully backed the banning of tyre warmers for this season with its LMP2 tyre.

'From the beginning of the development phase it was something we ensured, so none of our tests were run with tyre warmers. And running at the different tracks, in various temperatures, tyre warm up has been something the drivers have been very complimentary of so far,' says McGregor.

The target is to have the longevity of grip to manage a double stint, but to generate heat into the rubber quickly out of the pits, which then allows the driver to have confidence in the tyre under them.

This is no small challenge – track temperature variations in the WEC can vary from 4degC at Spa to 47degC at Aragon for the European Le Mans Series, and Goodyear's tyre has shown itself able to cope with that.

'Our R&D team has worked hard to ensure we have produced a tyre that works at the majority of circuits,' says McGregor. 'It is something we have been pushing for in prototype racing for a long time.

'Having that ability to have something that can work in the extremes, and endure it without having to take a different spec all the time, makes it a much more useable product.

'But it is much more about what we are developing for the future in production cars. If you take your road car and drive from the UK to the Nürburgring, and then do some laps of the Nordschleife – the extremes of temperature that you can cover across all those scenarios – you need one tyre that can do it, and that is similar to what we are doing with these race tyres.'

On the topic of the environment, like Michelin, Goodyear is also increasing the amount of recyclable material in its product, and the first iteration of the slick will have around one third sustainable material. The target is to double that through the rule cycle.

To produce a tyre that meets all these strict and extensive criteria put some rival manufacturers off, but Goodyear has clearly embraced the challenge.

'You can't look at sacrificing performance for the environment, you have to do these things hand in hand,' concludes McGregor. 'That's why Goodyear is in racing – to push the overall technology and learning and knowledge of tyres – and doing it at this limit, at this level, is the perfect environment for us to be doing just that.'

The new tyres must be capable of double stinting, and coming up to operating temperature quickly as tyre warmers are now outlawed in GT3. They must also work in a wide range of temperatures

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Performance enhancer

Italian constructor launches the ninth iteration of its Challenge single-make racing models at Mugello

By *RACECAR* STAFF

The one-make Ferrari Challenge is now in its 32nd season, and competitors around the world will have the chance to buy the latest model for competition in 2024. Based on the 296, which has raced in GT3 this year, winning the Nürburgring 24 Hours, it features the same V6 engine used in the GT3 and produces around 690bhp - more than enough for the customer driver.

However, the area of the 296 Challenge that Ferrari is most proud of is the new braking system. The CCM-R Plus discs bring carbon ceramic brakes to the car for the first time. The manufacturing technology uses long carbon fibres in a 3D, multi-directional matrix that delivers better thermal conductivity, while the silicon carbide ceramic coating improves durability and delivers an excellent coefficient of friction in the most extreme conditions, Ferrari tells us.

Disc cooling is by way of a complex layout of ventilation ducts, employing cutting-edge CFD computation techniques to optimise their geometry. The longevity of the CCM-R PLUS disc is around three times that of the regular CCM version, with apparently no tapering of performance whatsoever across its lifespan.

The ABS EVO brake-by-wire control system, introduced for the first time on the 296 GTB, has been evolved specifically for track use on the Challenge. This new controller uses the information from the six-way Chassis Dynamic Sensor (6w-CDS) to obtain a precise estimation of speed, enabling it to determine the target slip for all four wheels and optimise brake distribution.

This, in turn, allows the longitudinal force of the tyres to be better exploited when braking in a straight line and during turn-in when the rear axle is subject to the natural compromise between braking performance and lateral stability. Ferrari claims an average six per cent improvement at the rear alone with the new system.

Enhanced performance

Ferrari says the combination of the ABS EVO Track and the innovative brake discs means the 296 Challenge delivers vastly improved performance in terms of average deceleration and repeatability in extreme use, enhancing the new model's performance on track.

New Pirelli tyres specifically developed for the model contribute to this achievement.

To back up these claims, the 296 Challenge has been clocked two seconds faster around the Italian circuit of Mugello than the previous model, the outgoing 488 Challenge Evo, which made its competitive debut in 2020.

New carbon ceramic brakes have increased braking potential, Ferrari claiming a six per cent improvement at the rear

The 296 Challenge can generate 870kg of downforce at 250km/h with the spoiler at its maximum angle of attack

Significantly, Ferrari claims the 296 Challenge can also deliver that kind of performance improvement consistently throughout an entire 30-minute race.

At the beginning of the development process, it was decided to remove the hybrid elements from the V6 powertrain, as per the 296 GT3. With the electric motor and high voltage battery eliminated, the power output of the twin-turbo V6 was then boosted to 690bhp. This approach helped reduce the car's weight, as well as the complexity of the overall unit, which are fundamental factors for customer track applications.

Power increase

The new architecture led to the development of a more linear exhaust line located in the upper part of the engine compartment. The shape of the exhaust reduces back pressure by 30 per cent and is said to provide a significant contribution to the increase in power. The Gasoline Particulate Filter (GPF) used on the road car has also been removed, but the highly permeable catalytic converter normally used in racing remains.

Compared to the roadgoing engine, the Challenge specification sees a number of modifications to capitalise on the lower back pressure. The maximum speed of the turbos has been increased by 10 per cent to 180,000rpm, increasing the turbo boost pressure by a similar amount. Spark advance has also been

anticipated, providing a slight increase in pressure in the combustion chamber.

The result is a 35bhp increase in power compared to the roadgoing 296 GTB and GTS, with the same maximum torque output, albeit slightly lower in the rev range.

Removing the hybrid elements has also allowed for the introduction of an air conditioning compressor and 12V starter motor, both driven by the crankshaft via a dedicated belt, fulfilling the dual function of starting the engine and charging the car's 12V electrical system.

Aero development

The aim with the 296 Challenge's aero development was to use, and capitalise on, the knowledge built up with the 296 GT3. The primary goal of delivering downforce that is easily exploitable on the track was achieved by keeping variations and balance to a minimum, both on the straights and through corners. This makes the car agile, responsive and very predictable at high speeds, again important factors for customer drivers looking for performance and driving thrills.

The layout of the cooling system was also modified after the removal of the hybrid elements. The location and arrangement of the radiating masses is the same as on the 296 GT3, with the water radiator for the high temperature circuit at the front, and the condenser for the HVAC circuit ahead of it. The two rear-mounted intercoolers and the engine air filters from the car's roadgoing counterpart have been retained.

At the front, the engine coolant radiator is fed by an air intake in the centre of the bumper, designed to allow the maximum possible amount of cold air to be drawn in under dynamic conditions. The hot air coming off the radiator is then drawn upwards and exits through a vent in the bonnet, with specific wing profiles to optimise venting of the air from the S-Duct channel, situated immediately behind the radiator shroud. This GT3-derived solution increases the amount of cooling air flowing through the car and seals the car's underbody, a fundamental area in high-efficiency downforce generation.

Much work was done on honing the fluid dynamics of the brake ventilation ducts. At the front, the air intakes are on either side of the coolant radiator, while at the rear, cooling demands required separate ducts. Part of the airflow is drawn in through an intake on the sill, while a second airflow is directed through an aperture in the rear bodywork, just ahead of the fixed wing.

Downforce generator

The 296 Challenge can generate 870kg of downforce at 250km/h with the spoiler at its maximum angle of attack. This is an 18 per cent increase in downforce compared to the 488 Challenge Evo.

The car's aero design focused not just on the pursuit of performance, but also on driveability. To achieve both goals, the car's sensitivity to variations in downforce, and the aero balance to the car's ground clearance, yaw and roll were minimised.

Most of downforce over the front axle is generated by the splitters and the front section of the underbody, while the rear aero is dominated by the adjustable wing. The front underbody, with its raised central area, has been designed to create ground effect to keep the flow stable, even when the ride height is reduced under braking or in cornering. The central area is dominated by the S-Duct, which connects the underbody with the upper body to maximise the efficiency of the central diffuser and reduce the sensitivity of the 296 Challenge's aero balance to pitch.

There are two diffuser ramps, one on either side of the S-Duct, to create vertical expansion. Either end of the splitter, below the flick, is a separate wing section, which marks the debut on a closed-wheel competition car of the F1-inspired, double-element concept that makes downforce less sensitive to variations in trim.

Behind the S-Duct are three pairs of vortex generators, which create local suction and high-efficiency downforce. The side of the splitter has been designed to activate the underbody and manage the flows downstream of it, while the end plates manage the wake from the front wheels.

Fixed wing

Downforce generation over the rear axle comes mostly from the fixed wing, the angle of which can be adjusted to seven different positions. This allows the downforce level and balance to be set to meet the requirements of individual circuits.

Cooling package has been modified, after removal of the car's hybrid system. The GT3-derived solution, which exploits a central S-duct, optimises airflow through the car

Engine is the same twin turbo V6 from the GT3 car, but now producing some 690bhp, helped in part by a new exhaust system said to reduce back pressure by 30 per cent

Fixed rear wing has seven different positions, allowing teams to tailor the downforce level and balance it creates to the different circuits that Ferrari Challenge races on

The cockpit has seen a multitude of detail improvements, mainly based around ergonomics and driver comfort, notably the flow optimised air conditioning vents

The wing is supported by two aerofoil struts, which attach on the upper surface. This solution minimises aerodynamic interference on the underside of the profile, which generates most of the downforce and is more sensitive to flow disruption.

The wing's end plates are equipped with appendages that generate downforce and improve the efficiency of the lower edge of the profile, and the whole system works together with the rear diffuser and underbody, which has two pairs of vortex generators in its rear section.

The rear bumper has also been redesigned with respect to the 296 GTB, its vertical exterior profile having been optimised to reduce drag. Two vents have been added at the sides to channel air out of the rear wheelarches and into the car's wake, again to optimise the efficiency of the rear underbody and reduce overall drag.

Inner vision

The 296 Challenge's cockpit benefits from Ferrari's experience in both the single-make series and GT racing. The ergonomic Ferrari 488 Challenge Evo steering wheel design has been retained, but with a couple of small improvements. The position of the engine rev LED bar, for example, has been moved to the digital instrument display to make it more readable.

The cockpit has been updated with a more intuitive layout of the controls on the central tunnel, while adjustable, flow optimised air conditioning vents improve driver comfort.

The seat, which is derived from the 296 GT3, has been further developed to improve ergonomics, particularly in the head, shoulder and elbow areas, and the computer-designed rollcage complies with the latest FIA racing standards.

An LTE antenna provides a marshalling function (communications from the race marshals are sent directly to the instrument panel) and will be compulsory for cars competing in the Challenge championship. Further functions may be added successively.

The 296 Challenge will make its first appearance in the 2024 season in the Europe and North America series of the Ferrari Challenge Trofeo Pirelli. Its debut in the UK and Japanese series will be the following season. The 296 Challenge is the ninth model to be launched into Ferrari's single-make series, now the longest-running single-make championship on the international scene, following in the footsteps of the 348 Challenge (1993-'95), F355 Challenge (1995-2001), 360 Challenge (2000-2006), F430 Challenge (2006-2011), 458 Challenge (2011-'13), 458 Challenge Evo (2014-'17), 488 Challenge (2017-'19) and the 488 Challenge Evo (2020-).

TECH SPEC: Ferrari 296 Challenge

ENGINE	
Type	120-degree V6; turbocharged; dry sump
Overall displacement	2992cc
Bore and stroke	88 x 82mm
Max. power output	690bhp at 7500rpm
Max. torque	740Nm at 6000rpm
Specific power output	234cv/l (approx. 230bhp/l)
Max. revs	8500rpm
Compression ratio	9.4:1
DIMENSIONS AND WEIGHTS	
Length	4602mm (4851mm*)
Width	1958mm
Height	1159mm (1231mm*)
Wheelbase	2600mm
Front track	1715mm
Rear track	1647mm
Dry weight	1330kg
Tank capacity	140l
TYRES AND WHEELS	
Front	280/680 ZR19 J11
Rear	300/720 ZR19 J12
BRAKES	
Front disc	408 x 233 x 38mm
Rear disc	390 x 265 x 32mm
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By MIKE BRESLIN

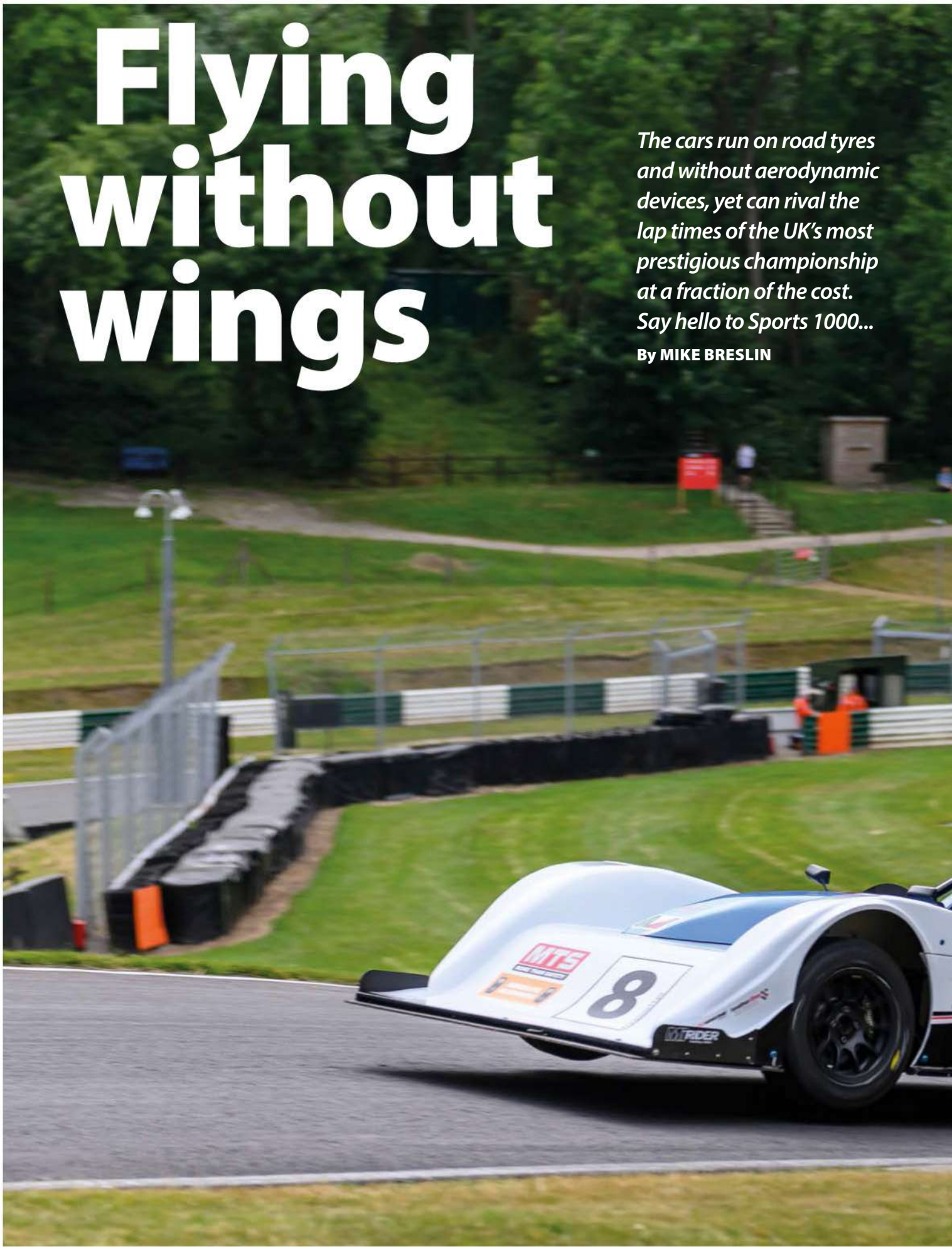


Photo: Jon Elsey

There are a number of series in existence that feature cars capable of lapping in times close to those set by British Touring Cars, or even faster. It's not unusual for a well-developed single seater or sports prototype, or even a highly modified saloon car, to rival or beat the UK's premier motor racing championship across a lap. What is unusual is for a car to do so with no wings or diffusers, while also running on road tyres.

One championship that does just this is Sports 1000. At Brands Hatch in recent years, its fastest times have been on a par with those towards the rear of the BTCC grid, which is little more than a second off pole. Not bad for cars with engines that only produce around 175bhp and have no wings or other aero elements – although that certainly does not mean no downforce.

This is especially impressive given that a Sports 1000 car can be run on a fraction of a BTCC budget. Indeed, those involved, even some who fight for wins, tell us that a season's racing can cost less than £10,000.

RGB ancestry

But perhaps this should not be a surprise, as Sports 1000 is part of the 750 Motor Club (750MC) family of value-for-money championships, so the technical regulations are firmly aimed at keeping costs in check.

These regulations have evolved enormously over the years, largely to keep pace with a category that itself has changed markedly since it hit the tracks as the Road Going Bike-Engined Championship, better known as RGB, over 20 years ago.

'It looked completely different from what it looks like nowadays, in that it started off as just roadgoing kit cars that someone had put bike engines in, and it's developed into what are basically out and out sports racing cars,' says Tim Hoverd, the formula's representative for the 750MC and, until the end of the 2022 season, a competitor in the championship himself.

The reason for this dramatic technical evolution is largely due to the regulations being relatively free, which has attracted entrants interested in the technical side of the sport. It also brings in constructors looking for a formula in which to build and sell cars – a very rare thing these days.

The Mittell MC 53 of Dan Clowes lifts off at Cadwell Park. Sports 1000 cars are big on thrills yet low on costs

Photos: Jon Elsey

A Mittell (21) battles with three Spires. These two makes account for most of the current field in Sports 1000, and both cars are very evenly matched on track, making for very close racing

It's even possible for someone to build a car themselves for Sports 1000 – the championship took this name in 2020 – and many have over the years. That said, there were no self-built cars competing at time of writing. The grid, with one or two exceptions, is made up of racecars constructed by just two concerns: Spire and Mittell.

At the sharp end, it's the relatively recent models from these two companies that tend to fight for victories, and this is because around seven years ago there was a paradigm shift in the design philosophy of the cars.

'Both ourselves and Spire brought out brand new cars for 2016, both longer and lower, and you couldn't fit the bodywork from those to the previous cars,' says Scott Mittell, of Mittell Cars. 'So, basically, you need a 2016 or newer car from Spire or us to be right at the front.

'To be honest, I think the new Spire [the GT-3] and our newest car, the MC 53, are very similar, so whoever's got the better driver in either car can win at the moment, which is quite a nice place to be for the championship.'

Clipped wings

While any sports prototype body will produce downforce, the Sports 1000 regulations have been clever in banning extraneous devices, like wings for example, to ensure aero development does not get out of hand.

'Basically, you can't have an aerodynamic device, and that's determined as something where air will flow above and below it,' says Spire Sports Cars boss, Tim Gray. 'Yes, the car can be described as a wing in itself but, beyond that, there are no devices such as wings and dive planes allowed.'

The underbody is similarly restricted.

'Essentially, we don't want people building tunnels and diffusers and all those sorts of things,' says Hoverd. 'So, the underbody has to be flat, although it can rise up at the rear, but then you're not allowed things like strakes there.'

With no aero extras allowed, other than flick-up-style spoilers and Gurneys, it's no surprise to hear the bodywork itself gets plenty of attention, and this explains the move to lower and longer bodies in 2016 – lower to cut drag and longer to make the most of the downforce produced by the body itself.

'A lot of the things we've done is to do with the body,' confirms Mittell. 'Although you've got quite a lot of power, there's not that much torque. So it's all about trying to reduce the drag, and the easiest way to cut drag is to reduce the frontal area. But we're still getting some downforce on the top surface.

'The floors are basically a flat floor with a diffuser [more of an upsweep] at the rear, but as you're not allowed strakes, they are not that efficient.'

'Yes, the car can be described a a wing in itself but, beyond that, there are no [aerodynamic] devices such as wings and dive planes allowed'

Tim Gray, Spire Sports Cars

Aerodynamic devices that allow airflow under and over are not permitted, so wings are out, though spoilers and Gurneys are allowed

Longer and lower designs were introduced in 2016 by both Spire (pictured) and Mittell. Drag is low but the body generates downforce

'I think one of the most important things about the championship is the [Nankang AR-1 control] tyres, in that we basically under-tyre the cars'

Tim Hoverd, Sports 1000 representative for the 750MC

Yet for a championship that is not really about the aero, development on this can still be at quite a high level. Spire, for instance, has left no stone unturned when it comes to shaving drag and finding downforce.

'We've used the MIRA wind tunnel quite a bit for our bodywork development, and we've done a lot of CFD,' says Gray. 'We then test it out on circuit, and correlate all three together, so we've a pretty good understanding of it.'

There's also nothing to stop customers tweaking the aero on their own cars and Ryan Yarrow, who was series champion in 2020 and 2021, and had just clinched the 2023 title when this was written, has done just this with his Spire.

'The standard car has 'arch spoilers [at the back] and a slightly different rear spoiler,' notes Yarrow. 'It also doesn't have the vents in the 'arches, which I just figured were a good idea, to try and evacuate any high-pressure air in the wheelarches.'

Yarrow has also tried to pare off even more drag from his car.

'I did a few test days with varying levels of downforce on it and found I could still drive it reasonably well with less on it, and it picked up a bit of speed,' he confirms.

Road rubber

While downforce producing devices are restricted, perhaps the more telling limitation, and one factor that certainly helps keep the budgets low, concerns the tyres.

'I think one of the most important things about the championship is the tyres, in that we basically under-tyre the cars,' says Hoverd of the Nankang AR-1 control rubber.

These road tyres are relatively cheap to buy, but the real money saving aspect comes from the limit on replacement.

'It's £394 (approx. $489) for four new tyres, and we're only allowed three sets a year,' says Stephen Hullock, a newcomer to Sports 1000, who campaigns a Contour, one of the few non-Spire or Mittell chassis on the grid.

The tyres have barcodes on them to help police their usage, but such is the durability of the Nankangs that there's little incentive to try to cheat the system.

'There's not much performance drop off, which is another nice thing, because when people throw money at tyres, it's a problem,' says Yarrow. 'I'm going to spend £1200 (approx. $1490) this season and maximise my allowance, but a lot of people might only have two sets. They're quite hard wearing.'

So hard wearing, in fact, that Yarrow ended up using only two sets of tyres this season, and still emerged victorious.

Moto-recycling

The approach with the tyres is a throwback to the roots of this championship, the 'roadgoing' bit in RGB, but the other part of that title is, of course, the defining theme: bike engines. Sports 1000 allows 1.0-litre sports bike engines from the four Japanese manufacturers: Honda, Suzuki, Yamaha and Kawasaki. The BMW S1000RR, which is growing in popularity in other motorsport formulae and categories, is not allowed to help keep the playing field level, so a regulation that once permitted all 1000cc motorcycle engines is now more proscriptive.

Yet while engines from the big four Japanese manufacturers are allowed, in reality only the Honda CBR and Suzuki GSX are fitted, although some have tried working with Kawasaki's engine in the past. The Honda and Suzuki units also need to have been manufactured before 2017 to be permitted.

Those active in the championship agree there's very little between these two units in terms of performance, so really it just comes down to personal preference.

Ryan Yarrow's Spire lifts an inside wheel at Croft. The spec, roadgoing rubber by Nankang is tightly controlled and has proved very hard wearing. So much so, Yarrow only used two of the three sets each competitor is allowed per season and still won the 2023 title

The engines, which generally give around 175bhp at the wheels, can be lifted straight out of a motorbike and transplanted into a racecar

'The Hondas and the Suzukis are the best engines,' says Gray. 'From the Honda point of view [Spire fits these into its cars], there are a lot of them around, so it was worthwhile us going to town on it, making a sump for it and doing the development work on it.

'The Suzuki is a little bit rarer. They were only made for two years, really. Even so, they're such a widely used engine in many other series that there is [performance] stuff out there available for them, and they're relatively cheap.'

Keep it simple

The engines, which generally give around 175bhp at the wheels, can be lifted straight out of a motorbike and transplanted into a racecar, but Mittell says it's better to rebuild them first. 'You can buy a low mileage engine off a crashed bike, and a lot of people just stick them in the car and go racing. We tend to get them rebuilt, as much as anything just to check they're legal, because you don't know if it has had something changed on it that you're not allowed to do.

'If we rebuild them, we know it's all completely standard and it's all fresh and ready to go. Sometimes you find some of the gears are a little bit worn, and the selector forks and things like that [gearboxes are integrated into the power unit with bike engines].

'We get them rebuilt and generally keep them in there for a year, and then we have them refreshed at the end of the year, and put them back in.'

Yarrow, on the other hand, is one of a few competitors who build their own engines.

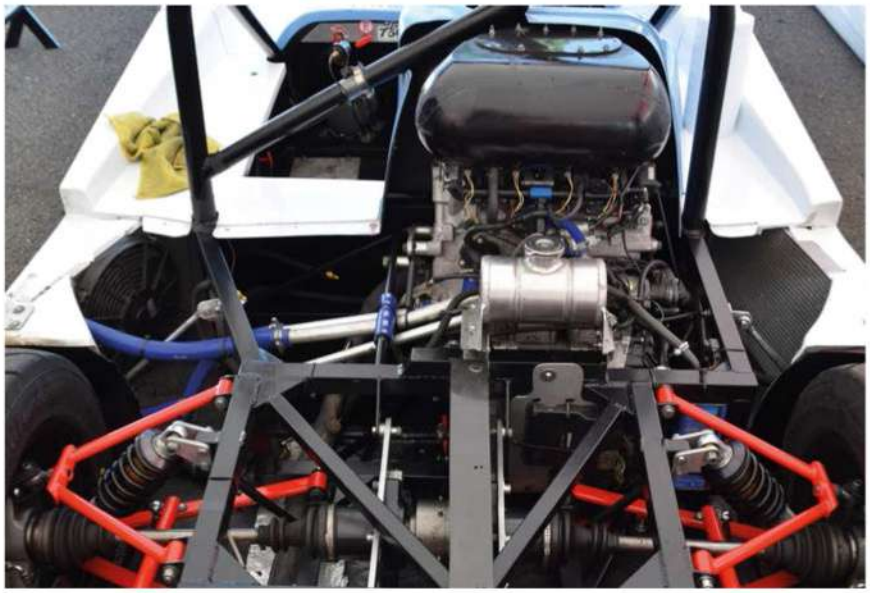
'On the Honda, you can upgrade the third gear, because it tends to blow,' he says. 'The only other things you can do are reliability mods that are known and allowed.

'All the breathing system is bespoke to the car, obviously the exhaust and the airbox, and you can map the ECU and the power commander, but other than that it's standard.'

They may be standard, but that's not to say they're not exciting, as these units rev to over 13,000rpm, and in a sustained way that is rarely the case on the road in a motorbike. This means they need to be very well lubricated, something that can prove a problem with bike engines in cars, due to cornering forces and resultant oil surges that the engines were not originally designed for. This has pretty much been sorted in Sports 1000, though.

'Problems with that are a thing of the past, really,' confirms Mittell. 'Everyone is using billet sump bases that have baffles and trap doors, which stop all those issues.'

The works Spire packs the Honda CBR 1000cc bike engine. While similar units from Yamaha and Kawasaki are also welcome, the only other motor in use is the Suzuki GSX 1000. All units are factory stock, bar some oiling modifications



Mittell always rebuilds its Suzuki engines after sourcing them, for peace of mind and to make sure it doesn't fall foul of any unknown - but illegal for the series - modifications made while they were fitted to the donor motorcycle

Keeping cool

More of a worry than lubrication is oil temperature, notes Gray: 'We have to do a lot of things to control oil temperature. The oil does more cooling than the water does in a bike engine because the water only cools the cylinder. You've got the whole crankcase, cylinder head, gearbox, everything, that's only cooled by oil.'

Of course, with a car that's designed to be as low drag as possible, cooling will always be a challenge.

'It's a big consideration,' says Gray. 'You'll always have people that want to get the most out of the aero and will want to run the thing as hot as you possibly can, but at this level, we're not in that game. What we need is cars that are reliable, so engines that will do two seasons without a refresh, and that will only happen if you keep it where the parameters are happy.

'We're already asking a little engine to do way more than it was supposed to do, and to ask it to be red hot at the same time, it's not going to like it for very long.

'We've had radiators laid forwards, sideways and backwards,' Gray adds. 'They've been everywhere, in trying to find where the right place for them is. And we've pretty much settled on where we are now. We can control [the cooling level] with the deflectors on the inside – they will rotate and pivot – so we can close the sidepod off, or we can

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There is a strictly controlled weight limit of 580kg, including driver, which is checked at the end of each race

open it, depending on if it's a warm day or a cold day. We also have some control on the cooling from that side, and a bit of aero but, at the end of the day, you've got to keep these things cool, or certainly cool enough.'

Shift work

As mentioned, the gearbox comes with the engine, which simplifies things greatly from a car build point of view. And it's become simpler still in recent years, thanks to the dropping of a regulation that said a reverse gear needed to be fitted – a costly and complex process and a hangover from the 'roadgoing' times. Otherwise, these are standard 'boxes, with none of the complications sometimes associated with bike transmissions.

'We specifically don't allow flat shifters in the formula,' Hoverd says. 'And we say you have to change gear mechanically. You can have paddle shifts, but they must be connected to the gearbox.'

There's also no auto-blip, and yet on the in-car footage of these cars – well worth a watch on YouTube – it's clear drivers are not heel and toeing.

'The beauty of these engines is you don't need to, because they're fitted standard from the factory with a slipper clutch,' says Gray. 'You can drop the clutch and the slipper clutch will look after you. It stops the rear end from locking, and you don't really need to heel and toe.'

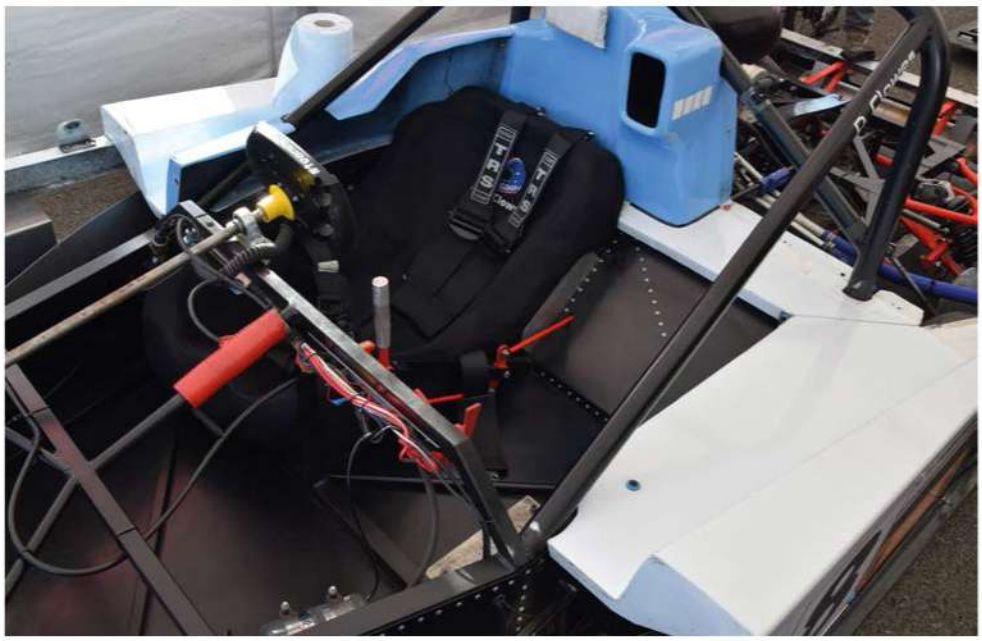
Furthermore, changing up, a driver does not even need to use the clutch.

'You basically just roll out of the throttle slightly, just enough to unload the torque a little, and you can do an upshift,' Gray says.

Despite these cars being almost 200kg heavier than the sports bikes their engines are taken from, OEM chains are the order of the day, and they seem up to the job. A Quaife ATB differential is mandatory.

Weighting game

Sports 1000 cars are not only marginally heavier than the motorbikes their power units are derived from; they're also a little heavier than some other contemporary bike-engined racecars. This is because there is a strictly controlled weight limit of 580kg, including driver, which is checked at the end of each race. Again, this helps keep down the cost of a car build.



The cars are strictly two seaters, and there must be space for an extra perch, even if no one ever sits in it. While paddle shift is allowed by regulation, the gear linkage must be wholly mechanical, so flat shifters are not allowed

Spire rear suspension. Dampers are free as long as they're only three-way adjustable to keep set up simple. The chain drive system uses the standard chain designed for the donor bike and has proven to be up to the task

'You're not having to spend loads of money on finding five kilos here, 10kg there, because the weight limit's high enough [so] that's not needed,' says Gray.

Of course, when it's a matter of weight in motor racing, there's only one man to talk to: Colin Chapman.

'The engine weighs 62kg, and that's gearbox and engine combined, so the weight of the car is so light [to begin with],' says Chapman, a Spire driver with no connection to the legendary Lotus founder (though presumably the offspring of motorsport fans!). 'I'm carrying about 15kg of lead in there, just to get me to the minimum weight, and that's a good thing as it means you can move the ballast around a bit and adjust the car with it.'

The weight limit also means there is no major push for costly lightweight materials, so while Kevlar and carbon fibre are allowed on the bodywork, it's really not worth the expense of using them and GRP is quite adequate. It's a similar story with the spaceframe chassis, where CDS tubing tends to be the steel of choice.

Suspension theory

Attached to the substantial looking spaceframes are quite different approaches to the suspension from the two major players in the championship.

'Our car's a double wishbone pushrod, so inboard damping,' says Gray of the Spire. 'Inboard, because it gives you another layer of adjustability. With a damper that's just

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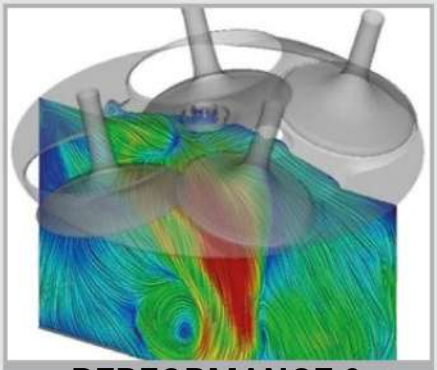

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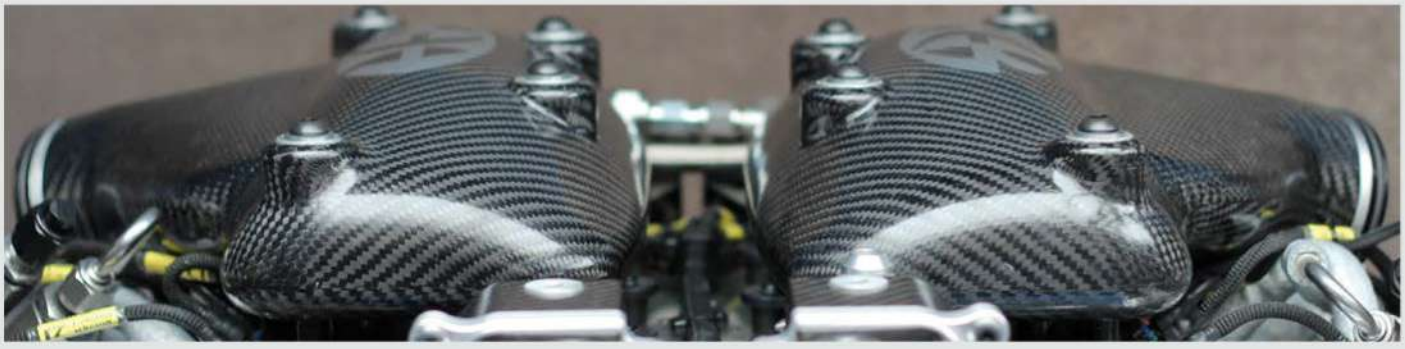

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'They're a bit of an ongoing conundrum, to try and get the best out of them, which a lot of people enjoy'

Ryan Yarrow, three-time Sports 1000 champion

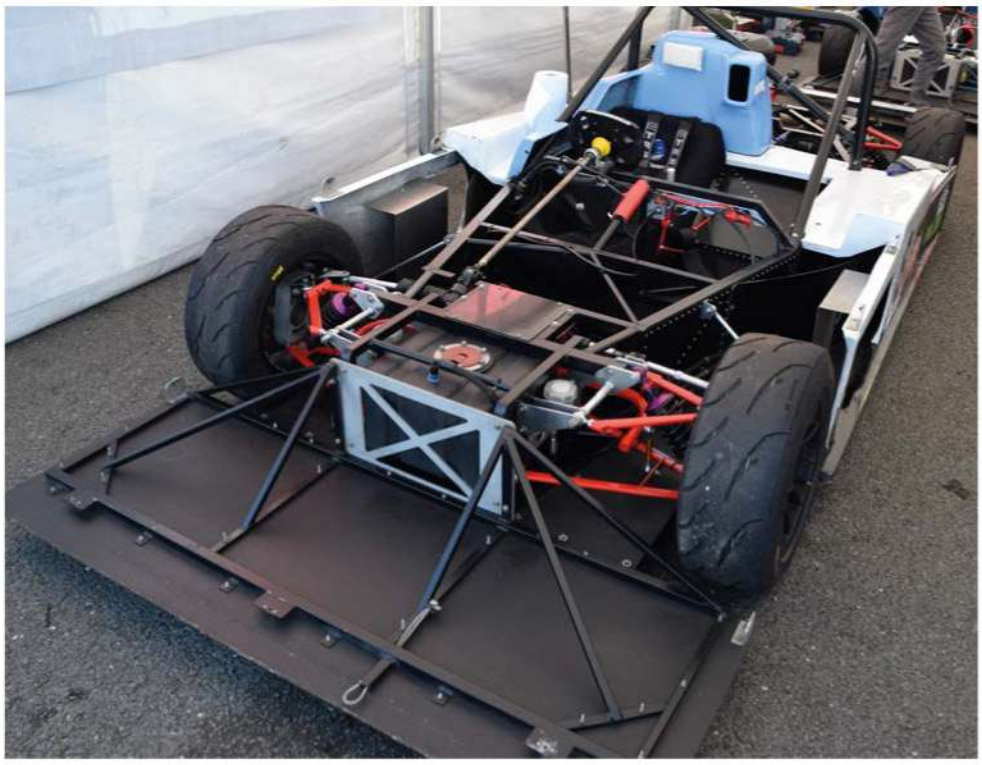
connected to the wheel, for instance, if you want to do anything, you're adjusting a spring platform, and straight away that's a limitation, because you've got a compromise between droop, bump compression and ride height. You can't adjust them separately. There's also a bit less unsprung weight with inboard, too.'

The Mittell, on the other hand, utilises an outboard suspension design.

'With a closed-in car, the advantage of using rockers, in our opinion, is not worth it for what we are trying to do,' says Mittell. 'We're aiming to make a car that's very easy to set up and very predictable. If you're running a professional Formula 3 team or something, then they're doing testing, they've got the shock engineer there, and if you get those bits right, that's fine. But with a nice simple outboard suspension, it's very quick and easy to set up and get in the window. Maybe if you've got the perfect set up inboard suspension, it might be better than this, but it's marginal. And obtaining that is very difficult on the short race weekends we have.'

The suspension is free in terms of design, but there is a limitation on the dampers, in that they can only be three-way adjustable. That said, there is certainly enough to do with the cars for those who revel in the engineering side of things.

'I think in the past people have struggled to place Sports 1000, because it's slower than slicks and wings, but faster than everything else,' says Yarrow. 'It's like everything about them is a bit of a compromise in terms of the set-up, because they're not full aero, so you've got to have a good amount of mechanical grip. They're a bit of an ongoing conundrum, to try and get the best out of them, which a lot of people enjoy.'



The Mittells have a simple, easy to set up outboard suspension that makes them simple to engineer and run. The weight limit is 580kg, including driver, so there is no benefit to spending big on expensive, lightweight materials in the chassis or bodywork

The Spire, on the other hand, looks more complicated as it employs an inboard suspension system that is operated via pushrods. The constructor points to a small saving in unsprung weight and says this philosophy offers racers an extra level of adjustability

Driving experience

Driving them is also said to be enjoyable. But because a sports prototype will generally have more downforce at the rear, aren't they prone to understeer? 'Not massively,' says Mittell. 'They're pretty well tuned now, and fairly well balanced. You tend to find you can get a bit of understeer if you're following other cars closely, because you're not getting that much downforce from the underfloor, and don't have front diffusers and things like that, so you lose a bit of front-end downforce when following closely around high-speed corners.'

Not that this detracts from the thrill, as Gray, who is a very quick driver of these cars in his own right, testifies: 'Every time you get in one of the cars, you ask yourself how are we going so quick on a road tyre with no aero? They're just phenomenal cars to drive.'

It's no surprise, then, that the grids are healthy, while many involved in Sports 1000 say it's becoming increasingly difficult to find a car to buy right now. If you do find a second hand one for sale, expect to pay around £20,000 (approx. $24,850) for a good example, or as little as £14,000 (approx. $17,400) for some, with the vintage very much the driver here. Understandably, pre-2016 designs tend to be significantly cheaper.

Meanwhile, a new car can cost around £35,000 to £40,000 (approx. $43,500-$49,700), which is not bad at all, when you consider you're buying a machine that's as fast as a British Touring Car over a lap.

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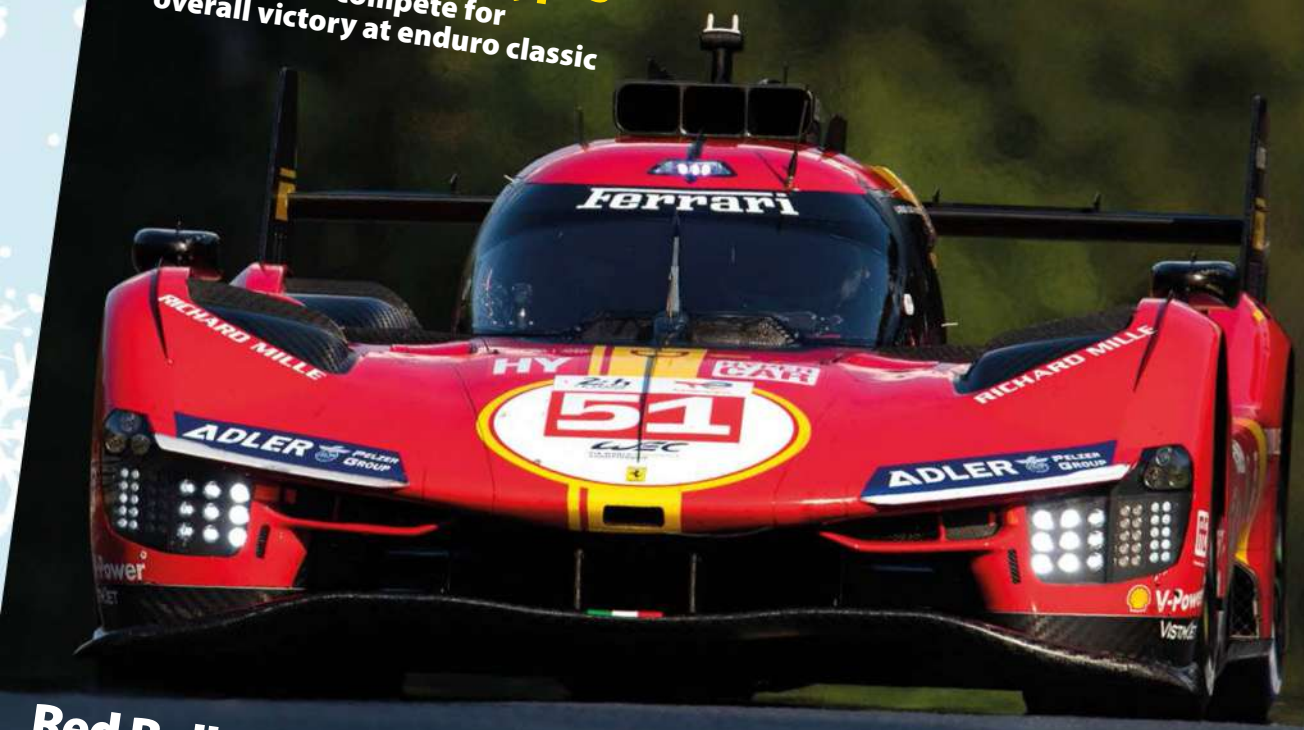

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All-seeing eye

From gentleman driver to one of the world's leading sportscar designers, Paolo Catone has been there, seen it and, pretty much, done it all

By LAWRENCE BUTCHER

Look at any Le Mans field from 1992 until the end of the LMP1 era, and you can guarantee there were cars at the sharp end of the grid designed by Paolo Catone. If fact, it may not be an understatement to say that no one else has penned as many sports prototype designs as he has.

However, for Catone, his career did not start out in sportscars. It was single seaters where his involvement with racecar design began in 1982. 'I started out as a gentleman racing driver, spending my Saturdays and Sundays running around, winning some races. But, at the end of the day, I was good, but not good enough,' says Catone with refreshing honesty.

Though he had an engineering background, he was not involved in racing for a living at the time, but that would change when some friends asked if he could design a Formula 3 car.

'I had a contact at Minardi and, discussing with them, they decided to give us an ex-Formula 2 chassis,' he recalls. 'We modified the suspension, put in the Formula 3 engine, and made something that could do some races in the European championship. It was really amateur.'

Amateur it may have been but, in 1984, things changed dramatically when Giancarlo Minardi decided to go Formula 1 racing.

'He asked me if I was interested. I dropped everything I was doing and said yes!'

Concurrent to the F1 project, Minardi was also trying to get an F3000 project off the ground and it was this that Catone initially found himself working on.

One in four

'I came in to help one engineer transform the F2 car to F3000 but, when he left after one month, I was left alone in charge. At the same time, I was also working on the F1 bodywork. Because at the time, the drawing office was just four people – one doing calculations, two doing mechanical and one for the bodywork.'

So it was that just two years after his very first stab at racecar design, Catone was working on Formula 1 cars.

'I started out as a gentleman racing driver, spending my Saturdays and Sundays running around, winning some races… I was good, but not good enough'

Francois Flamand / DPPI

XPB

After Alain Prost bought Ligier, Catone returned for Team Prost's F1 programme. Seen here at the Canadian GP in 1997

The F3000 project was short lived and, within a year, Catone was exclusively on F1 duties. 'I was in charge of all of the composite parts, and then, one day in '86, Minardi came into the office and said, "Okay, we need a carbon chassis." Within two hours, I was responsible for 70 per cent of the car.'

He takes a moment to point out that all this work was being undertaken on a five-metre drawing board, at 1:1 scale.

The development of the carbon chassis also marked Catone's first dive into the world of serious aerodynamic research. 'At the time, there was no wind tunnel for us. The chief engineer was ex-Ferrari and he would say, "Okay, we do it like this. Look, our sidepods are high like this, but everyone else is down here, so there must be something going on somewhere"', he chuckles.

When Catone suggested to Minardi that they need to do some wind tunnel testing, the boss replied, '"Okay, if you take charge of that in addition to your other work, we will do it". So, in my extra time I prepared the model and we took it to the wind tunnel, and that was my first experience of aero.'

That was in 1988, and the resultant M188 was also the first of the team's cars designed in CAD, something Catone had also pushed for with Minardi.

'It was very simple CAD, Computer Vision at the time,' he recalls. However, despite being on excellent terms with Minardi's founder, changes within the team meant Catone became restless.

Peugeot calling

That's when he received a telephone call from France: 'Peugeot contacted me about the 905 project,' he says. Although he had been predominantly involved in F1, Catone had already turned his hand to sportscars with the MCJ86, which was to be Minardi's entry into Group C2, powered by the same Motori Moderni V6 turbo used in F1.

The Peugeot 905 wasn't Catone's first foray into the world of sportscars, but it was the one that really put him on the map when the re-designed Evo 1B won the 1993 24 Hours of Le Mans for Peugeot Talbot Sport

Unfortunately, the project never made it off the drawing board. 'I had experience in composites, F1 and the same CAD system Peugeot was using for its bodywork, because CATIA at the time was only used for mechanical design. They had the new system but no specialist to use it, so they called me and I was put in charge of the chassis and bodywork.' It was a challenge that Catone readily accepted.

'It was a great experience. In six months, I designed two sets of bodywork. If you remember, the first 905 was very stylish, but it didn't work. Fortunately, we had a very good aerodynamicist come in during the season and we completely re-designed the bodywork and ended up with a winning car.'

The 905 programme would also mark Catone's first taste of race engineering. Like so many things in motorsport, it was out of necessity rather than choice.

'Like in all big teams, you end up with a problem in communication between trackside, the drawing office and so on, so we pushed to have a connecting point. We needed someone from the drawing office trackside when we went testing, to keep everybody happy. They said, "Okay, you do it"'.

He started to attend all the tests and, when Peugeot moved to running a third car, he was the logical choice to race engineer it.

'I started at Le Mans in '92, when we had a broken engine and a big accident, but then in '93, I won with Bouchut, Helary and Brabham.'

Peugeot, meanwhile, had been running the 905 Evo 2 in testing but, as Catone recalls, 'It was hyper fast, but too big an investment and we were not sure on the reliability. We decided instead to just introduce some modifications from the Evo 2 in the Evo 1B, and that was the car that won in '93, then the programme was stopped.'

Courage building

Out of a job following the closure of the 905 endurance racing programme, Catone dabbled with some more F3000, but also commenced what would be a long relationship with racing car constructor and race team owner, Frenchman Yves Courage. 'I started on the first carbon tub for Courage in '94, the C41,' says Catone.

The car was something of a Swiss army knife. 'That car had a lot of different engines. We had the Chevy initially, then the Nissan and also the Porsche, lots of different versions.'

The C41 would morph into the C51, C50 and C52 over the next five years. In 2000, a C52 run by Pescarolo and fitted with a Peugeot A53 engine finished fourth at Le Mans, the fastest non-Audi, and the last time a C41-based car competed in a major race.

But Catone was not standing still and, having finished the C41, he was called up by Ligier as a race engineer in Formula 1.

XPB

When Giancarlo Minardi entered F1 in 1985, Catone was his first call, though he initially worked on the company's F3000 programme

XPB

Even when updated to the 185B for the 1986 season, the car was still hampered by its unreliable Motori Moderni V6 turbo power unit

XPB

The 185B only finished three races in 1986, but gave Catone the opportunity to design a carbon chassis and to explore aerodynamics

XPB

Catone started working with Yves Courage in 1994, and their final collaboration was the LC70 that raced as an LMP1 in 2006

XPB

Catone recalls his return to Peugeot in 2006 with fondness, saying the 908 programme was one of the best experiences of his career

Lawrence Butcher

The designer's input into the 908 was huge, even down to demanding a change of vee angle for the V12 engine to lower the car's c of g

Lawrence Butcher

In 2013, Catone was asked by SMP Racing to design an LMP2, the BR 01

'In 1996, I won in Monaco with Olivier Panis,' he recalls. He stayed with the team through its sale to Prost and was responsible for all track engineering and testing. He was also given responsibility for F3000, but did not find the role particularly fulfilling, so found his attention drawn back to Courage and development of the C60. However, just as design work on that was drawing to a close, Prost asked him to move back into F1.

'I ended up doing the two at the same time but, luckily, the majority of the C60 design was already complete.'

In addition to his work with Courage during this period, Catone also found time to knock out another single seater, the SLC R1 for Italian outfit, ATR Group. The car competed in the 2005 Formula 3 Euro Series with a single entry, piloted by Brazilian Fábio Carbone, though as it was the only non-Dallara chassis in the field, it was always going to have its work cut out.

'The [Peugeot] 908 was the first car that I really could do whatever I wanted, no compromise. I was able to push it in every field, even the engine'

Catone confirms that: 'When you are one against 20, it is quite difficult, and it was the year [Lewis] Hamilton won the championship. Nevertheless, we still managed a couple of top five finishes.'

Returning to sportscars, Catone started work on his last effort for Yves Courage, the LC70 for the new LMP1 class. The LC70 would go on to spawn multiple derivatives: the Courage-Oreca LC75 in LMP2 (after Courage was taken over, with the LC70 becoming the Oreca 01) and two types of Acura ARX-01. It also went on to form the basis of the Oreca FLM 09 Formula Le Mans car.

Swiss outfit Hope Racing even equipped an 01 chassis with a hybrid system and 2.0-litre VW engine from Lehman in 2011 for Le Mans, but only managed 115 laps before retiring.

908 degrees of freedom

Barely was the ink dry on the last drawings for the C70, when Peugeot came knocking once more. 'They called and said, "We're coming back to prototypes, was I available?" So obviously, I said yes,' says Catone.

For Catone, the opportunity to return to France was too good to pass up. 'It is one of the best experiences I've had, because the 908 was the first car that I really could do whatever I wanted, no compromise. I was able to push it in every field, even the engine.'

On this last point, Catone was even able to dictate the engine layout, with the only condition from Peugeot being it was diesel.

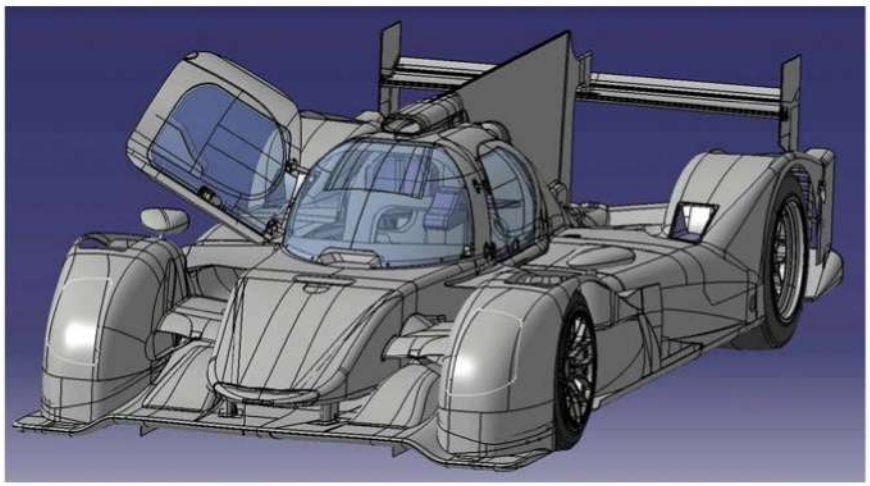
'They started to tell me it had to be a V10, with this bank angle etc, and I said, no, it must be part of the structure. We did an extensive study from V8 to V12, with all of the ranges of vee angle, to find the best layout.

'I wanted the engine to be part of the structure, but also with the lowest c of g, so quite an open vee. This was because the cylinder heads were very heavy. If we could open the angle a bit, we could move 100kg of mass 30mm lower. That's how we ended up with the 100-degree angle.'

The scope might have been broad for Catone, but the development timeframe for the 908 was exceptionally tight.

'I officially started in January 2006, and we had the first shakedown on the 31 December that year. That was starting from a blank sheet of paper,' the designer remembers.

'I think I was the first person to homologate a NASCAR chassis with the FIA, with crash tests and everything else'



Politics prevented SMP Racing's BR 01 fulfilling its potential but, when the Russian billionaire team owner announced it was going to enter LMP1, Catone suggested a design, only to have the contract awarded to Dallara

Peugeot had informed Catone that the 908 would be diesel-powered at their first meeting, and he was pragmatic about the somewhat left field choice of engine.

'I listened and just said, okay, it's a challenge but why not, we will just do it the best way possible, and it was not so bad.'

That first car, the 908 HDi FAP to give it its full name, was blisteringly fast. On its debut at the Monza 1000km in 2007, the two Peugeots qualified a second clear of the rest of the field, and even though one car dropped to third in the race due to issues with its doors, the no.7 car driven by Marc Gené and Nicolas Minassian secured a maiden victory.

Come Le Mans and the 908 was on pole again, but the team had to settle for second to Audi in the race. Regardless, Peugeot took the Teams' title in the Le Mans Series.

The 2008 season looked to be Peugeot's year, the 908 dominating the Audi R15, but it was not to be. Catone doesn't go into great detail as to the reasons behind this, beyond saying with a grin, 'I have enemies but, if I go into it, I'll have more. It was just stupid things, bad strategy, bad choices and so on.'

At Le Mans that year, the Peugeot was untouchable, and the Audi some seven seconds off the pace, but multiple pit stops during the race to clear debris from the cooling inlets allowed the Germans to take the win. Even more galling, despite winning every race until the season-closing 1000km of Silverstone, where both 908s unfortunately fell victim to accidents, Peugeot lost the Drivers', Teams' and Constructors' Championships to Audi that year.

Success at Le Mans would finally come in 2009 but, by that point, the relationship with the French manufacturer had soured. 'I left the company because I said, look, you do stupid things, you don't need me!'

HP Composites

Never one to sit still, Catone kicked off a new project, setting up a composites company with some friends that had previously been his suppliers. The result was HP Composites, and the first job they had, before even finishing their building, was the Lotus T125 single seater.

'They had already launched the project, but there were problems,' recalls Catone. 'They called me and asked me what I thought. I said you have to change this, this and this, and they replied, "When can you start?"'

HP Composites would take on a variety of projects, including work on Ligier's first carbon-tubbed CN car, the JS53, but running a company was not entirely up Catone's street and he sold his stake after a couple of years, moving on to other projects. He dismisses these as unimportant, but then quips cryptically, 'I think I was the first person to homologate a NASCAR chassis with the FIA, with crash tests and everything else.'

It was perhaps inevitable that Catone would end up back working on sportscars but, initially, this was not in the form he was used to, running a GT team for SMP Racing.

'SMP started in 2013 running Ferraris, and was only formed two months before the 2013 season started,' he recalls. 'During that exercise, they asked if I could help with the set-up side of the cars. I said I had zero experience in GT, but it was more the organisation and testing they actually wanted assistance with.'

The decision for the team to move into LMP2 happened almost by accident, with owner, Boris Rotenberg, suggesting over a dinner in mid-2013 that such a programme might be a good idea. Soon after, they asked Catone if he could design such a car, to which he said he could, and soon after began to put together a feasibility study into what would be required.

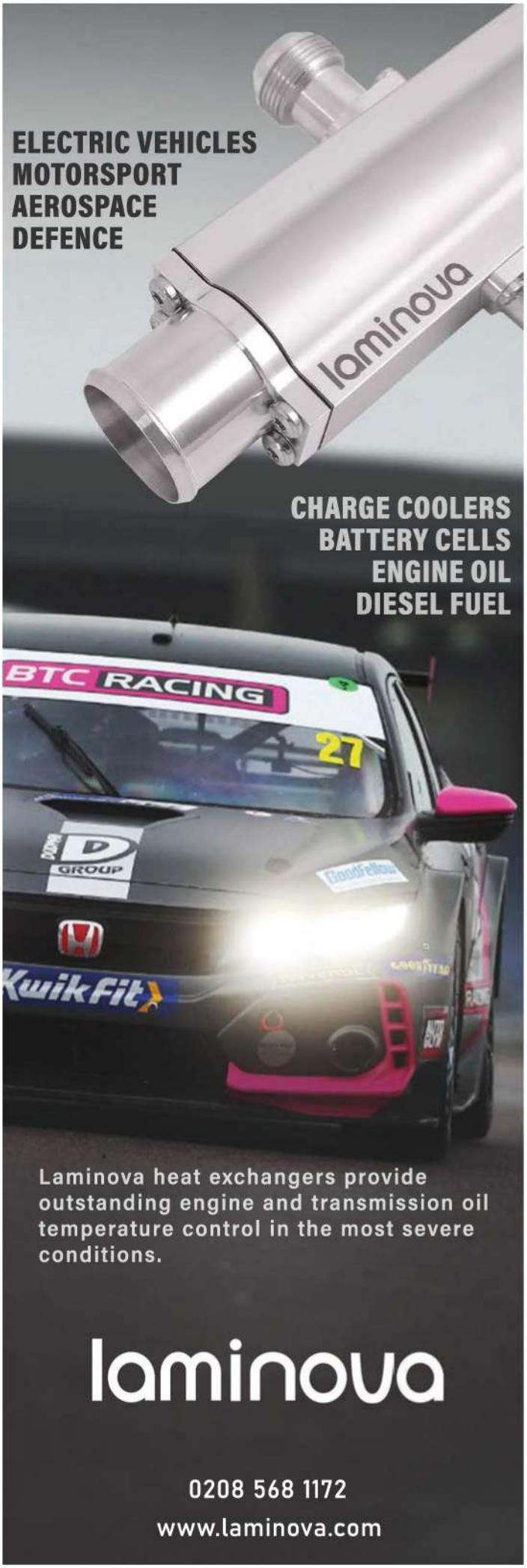
'I made an initial study at the end of December 2013, which just outlined what we needed and how much it was going to cost. I was in Daytona for the 2014 24 Hours and gave the dossier to Boris to consider. He opened the file, browsed through it and then said, "Okay, when do you start?"'

So it was that SMP was heading into prototype racing. By then, it was January 2014, which left a very short timescale to develop a new car from the ground up in time for the 2015 WEC and ELMS seasons. What was already a tight schedule was then further compressed by a variety of delays.

'The real work of building the car began in February 2015,' says Catone. Originally, in mid-2013, the team decided that if it was to build

Lawrence Butcher

Catone's final sportscar design was the Ginetta G60-LT-P1. Blisteringly fast, it was again let down by its original engine, this time a Mecachrome unit, and a lack of testing. Funding issues and Covid put an end to the programme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'I participated in the adventure with Yves [Courage]. Racing was so important to him, even on small amounts of money. I helped him for nearly 20 years to continue his activities and I am proud about that'

XPB

SMP Racing was formed in 2013 to go GT racing, but quickly moved into the prototype realm. Unrealistic targets, and politics, meant the car missed is 2014 debut but made a decent showing in 2015, despite being hampered by unsuitable tyres and a lack of testing

a car for LMP2 then it would want it ready for November 2014. Despite the green light not being given until the end of that year, November remained the target.

'If we had started in the summer of 2013, we could have met that date. But the decision was not made until January 2014, so we already started behind schedule.'

It was at this point that the worlds of international politics and motorsport collided. The team's primary backer was SMP, a large Russian bank of which team owner, Rotenberg, and his brother, Arkady, are major stakeholders. So when the bank was subject to EU and US sanctions, as part of wider financial penalties placed on Russia for its annexation of the Crimean peninsula in Ukraine, the team found itself unable to pay suppliers. These problems came as something of a surprise to Catone and his small team that was rushing to create a car from scratch.

'We could not pay for things, and we even had a case of having a payment going to a supplier and the bank sent it back. We asked the supplier why they had not started work and they said they had not been paid. It was then we discovered the bank was just sending payments back, but not telling anyone they had done so. These problems meant we had some delays on the delivery of parts, and then suppliers were overloaded with F1 business. With those problems to deal with, it was not until February 2015 that we finished the first car. It was really complicated.'

Customer racing

Despite these dramas, the finished product was good, but lacking in testing. 'The idea behind the car was for it to be suitable for customers,' explains Catone. 'That means it must be comfortable inside, with good visibility and accessibility. It was a car that needed to be sold and, if a customer sat in the car and it was not comfortable, they would not buy it.

'Gentleman drivers are not always very thin, or athletic. For example, one of our drivers who tested the car in the early days was a big chap, and if the car fitted him, it could fit anybody.'

The three months of delay meant the BR 01 entered its first race having only run 500km of testing. Not a good start.

'We also had the bad luck that, in that first year, we were on Michelins, which didn't work at all. We actually did a secret test, with other teams, on the Dunlops and were the fastest.'

In the end, the BR 01 had a reasonable run, but the team wanted to move to LMP1.

'I prepared something, but they told me it was too expensive, only to then go with Dallara, who for sure are not cheaper than me!'

Last hurrah

The final sports prototype that Catone was involved in was the Ginetta G60-LT-P1, which was supposed to be a halo project for the small British constructor. Unfortunately, circumstances would conspire against it.

'The car was extremely fast. We got an aerodynamic package that was very good, thanks to Andy Lewis [formerly of Williams F1], and the chassis was very good, we carried nearly 80kg of ballast.'

Again, though, a shortage of testing, coupled with a woefully underperforming Mecachrome engine, let the project down. During the car's run out at Le Mans in 2018, the lack of power put the G60 well down the pecking order, despite clocking similar pace through the Porsche Curves as the leaders.

The G60 would go on to secure a couple of strong results in the WEC, including a fourth place at the 2019 Silverstone 6 hours, but ongoing funding issues, and the arrival of Covid in 2020, shuttered the project.

Catone says he is now retired, but is currently involved in a secretive road car project, and is clearly relishing the challenge.

Looking back on his career, the 908 is a standout achievement, but he also flags up the BR 01: 'At the end of the day, it didn't get the results we expected but, considering the money we had, the time we had, and the way we did it, I think it was a good project.'

He also looks back on his relationship with Yves Courage fondly: 'I participated in the adventure with Yves. Racing was so important to him, even on small amounts of money. I helped him for nearly 20 years to continue his activities and I am proud about that.'

Throughout his career, Catone has adapted and embraced new technologies, but fears for the young engineers of today.

'I am sad because they will never have the same range of experience I did. I started on a drawing board, designing by hand, with aluminium chassis. No telemetry on cars, anything like that. The engineers now only know the new technology, which is good, but it is a limiting factor. They are super specialised now and very good at what they do, but there is less of the overall view.'

Catone now says he is retired, but is currently involved in a secret road car project; a first for the man who spent his whole career in motorsport

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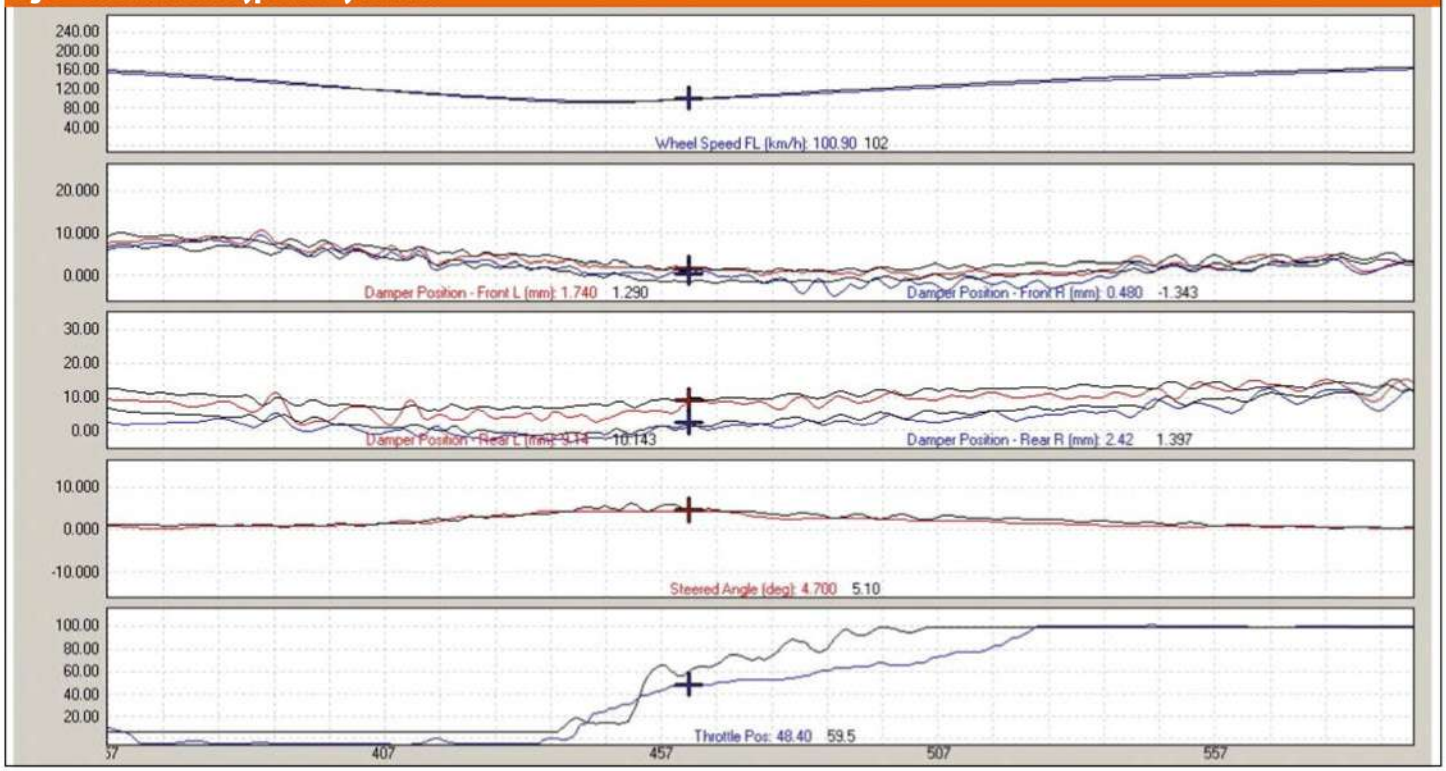
BEGINS NOW

Connecting the dots part 2

Continuing the tyre temperature modelling mini-series, this month we consider tyre surface temperature

By DANNY NOWLAN

Fig 1 – Correlation of a typical 2D tyre model



In part one of tyre temperature modelling series last month, we talked about the two temperature metrics to watch for in a tyre: internal and surface temperature, and what they look like.

We then discussed the effects of internal tyre temperature and pressure, and how that affects grip. This month, we are going to look at the effects of tyre surface temperature on grip, and how you can model it.

To put where tyre surface temperature modelling fits into context, we need to take a step back and consider when the traction circle radius is a function of load only. I often refer to this as a 2D tyre model, a typical correlation of which is shown in **figure 1**.

A 2D tyre model is an excellent first cut toward obtaining a very useable and effective tyre model. You can also get a fair way down the road with this, particularly with a model you are using for DiL. In fact, you may well find this becomes your go-to model of choice when you are bringing a driver up to speed.

What it lacks is the nuances of what happens when you over drive the car and the finer set-up sensitivities. The tyre surface temperature model plugs that gap.

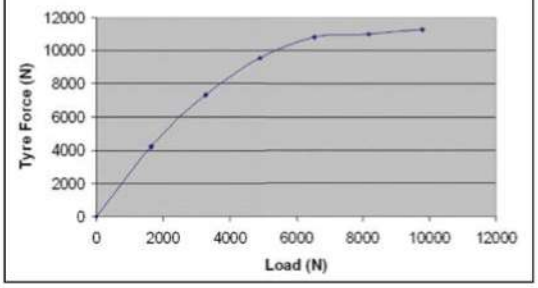
Before we discuss this in detail, it would be remiss of me not to state the warning labels on using this. With tyre pressure modelling, you can get a good gauge of where you need to be but, when you start doing tyre temperature surface modelling, if you don't have infrared (IR) sensors, you are seriously on the back foot, which is why this needs to be conducted with great care.

Also, if you don't have a good, solid 2D tyre model done first, don't even bother doing a temperature surface model for, to quote my late mother, you'll be on a hiding to nothing. So, make sure you have a very solid 2D tyre model in place well before you start the tyre temperature surface modelling. An example of this is shown in **figure 1b**.

Thermo' modelling

When thermo' tyre modelling was first introduced to ChassisSim in 2010, the biggest mistake myself and other ChassisSim users made was trying to run before we could walk. The lesson was learned very quickly that if you didn't have a solid 2D tyre model first, you might as well not even bother turning up with a thermo' model.

Fig 1b – A traction circle vs load only model



The other thing to take into account when you start working on this is that you *must* do this on a high-grip circuit. To explain, let's examine **figure 2a**, which shows the temperature surface variation for a live axle V8 Supercar at Homebush (a low-grip circuit) and **figure 2b**, at Sydney Motorsport Park (a permanent circuit, which is a lot faster).

If we review the temperature plots of both, the tyre surface temperatures are 20degC higher at the faster, higher grip track. This is due to the fact that Sydney MP has a lot more faster corners than Homebush. Also that particular thermo' model was developed around Homebush, so at Sydney MP the

Fig 2a: tyre temperature plot for a V8 Supercar at Homebush

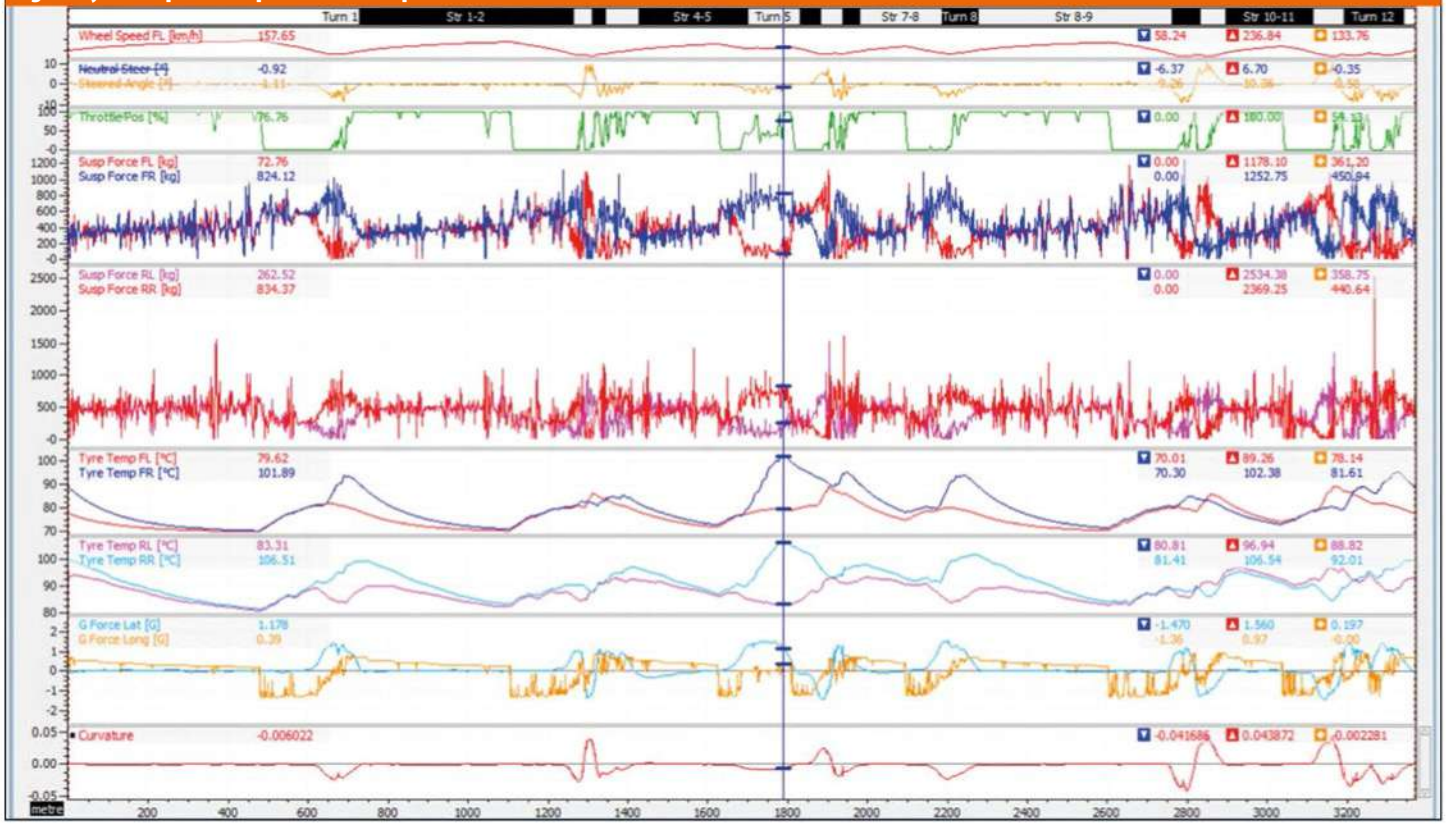
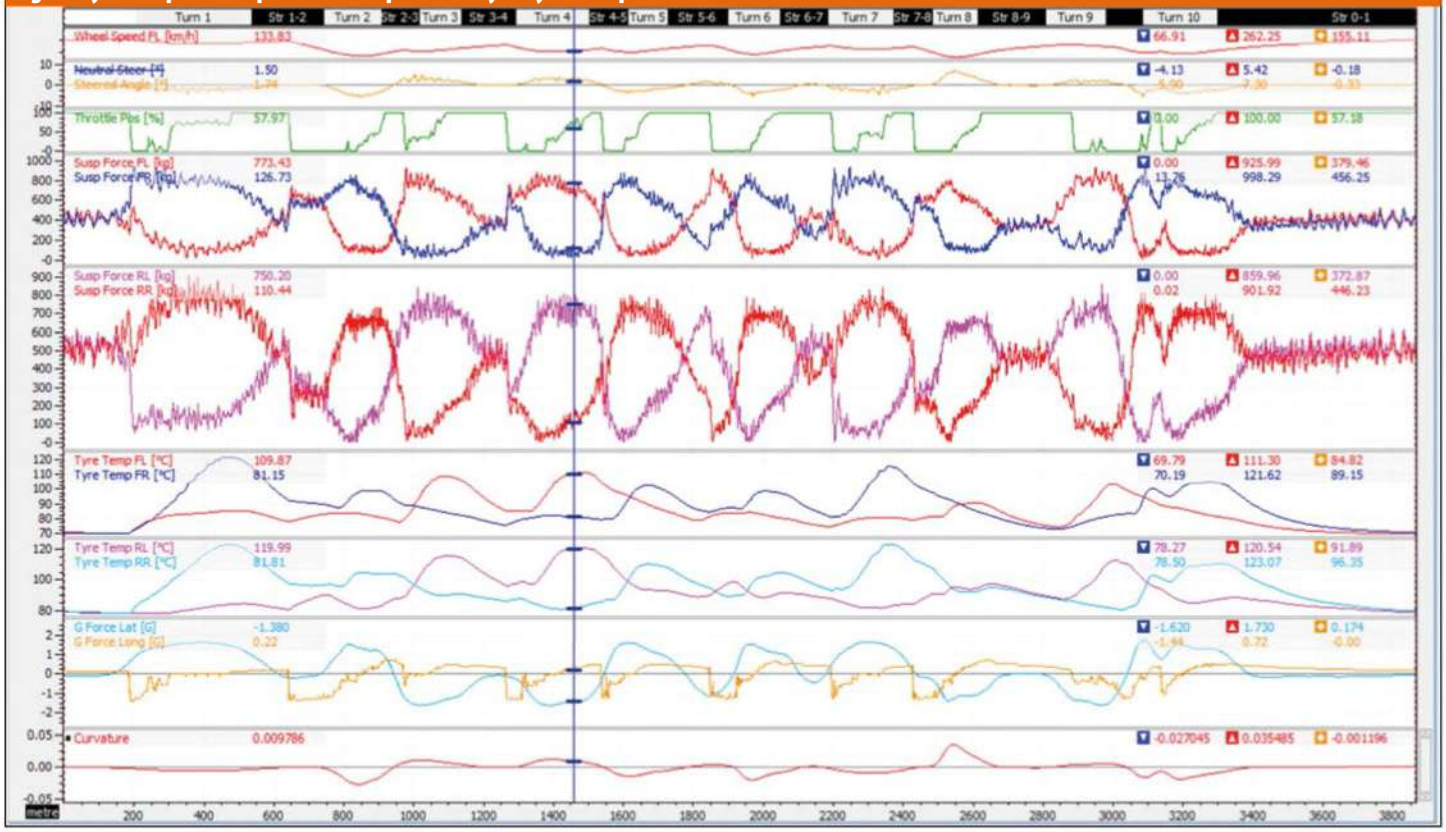


Fig 2b: tyre temperature plot for V8 Supercar at Sydney Motorsport Park



temperatures will jump big time. This puts into sharp relief the necessity of starting on a high-grip circuit, or you'll be in big trouble.

The other thing to watch for is what to expect in terms of surface temperature variation. If you have IR sensors on your car then this question is answered for you. If you don't, you'll find **figure 3**, a temperature plot of an early 2000s sports prototype, most instructional.

Note the differentials. We are talking 25degC or so occurring just after peak steering lock. And, at 115km/h, this was quite a low-speed corner. More typically, you are looking for variations of 35-40degC in high speed / high grip turns.

Before we discuss the tyre temperature model, we need to consider how you dial all this in on your simulation package of choice. First things first. You are using a track replay / open loop simulation approach where you are taking the driver steer, throttle and brake inputs and running them through the numerical engine. What you are looking to do is match the corner peaks and general lag (I have a couple of tutorials on the ChassisSim YouTube channel where I cover this at length).

If you attempt to match every detail of the temperature characteristic you'll spend a lot of time with minimal return on investment.

Now that we have all this preliminary stuff out of the way, we can discuss how tyre surface temp affects tyre grip. A very useful approximation for the traction circle radius is shown in **equation 1**.

$$TC_{RAD} = fn(F_Z) \cdot fn(T_S) \quad (1)$$

Where,

TC_{RAD} = the traction circle radius in N
F_Z = vertical load on the tyre
T_s = middle / core surface temperature

The *fn(Fz)* we all know and love is our typical TC_{RAD} vs *Fz* curve that I have discussed on multiple occasions before. The function *fn(Ts)* has a maximum value of one.

You have a couple of options for the temperature surface scaling. The first is the square function, which is described mathematically in **equation 2**.

$$fn(T_t) = 1 - k \cdot \left(\frac{T - T_{OPT}}{T_{OPT}}\right)^2$$
$$T \le T_{OPT} \rightarrow k = k_{pre} \quad (2)$$
$$T \ge T_{OPT} \rightarrow k = k_{post}$$

Here we have,

T_{OPT} = optimum operating temperature of the tyre in Kelvin
T = mean tyre temperature in Kelvin
$kpre$ = slope of tyre temperature before peak temperature
$kpost$ = slope of tyre temperature after peak temperature.

Some typical values are described in **table 1**.

Table 1: typical values of square function of the thermo' temperature tyre model

Parameter	Value
T_{opt}	373.15K
k_{pre}	7
k_{post}	15

Graphically, this will look like **figure 4**.

Your other option is to use the exponential function. Mathematically, this is described in **equation 3**.

$$fn(T_t) = k_{MULT} + (1 - k_{MULT})e^{k\left(\frac{T - T_{OPT}}{T_{SCALE}}\right)^2}$$
$$T \le T_{OPT} \rightarrow k = k_{pre}, k_{MULT} = k_{exp\_pre} \quad (3$$
$$T \ge T_{OPT} \rightarrow k = k_{post}, k_{MULT} = k_{exp\_post}$$

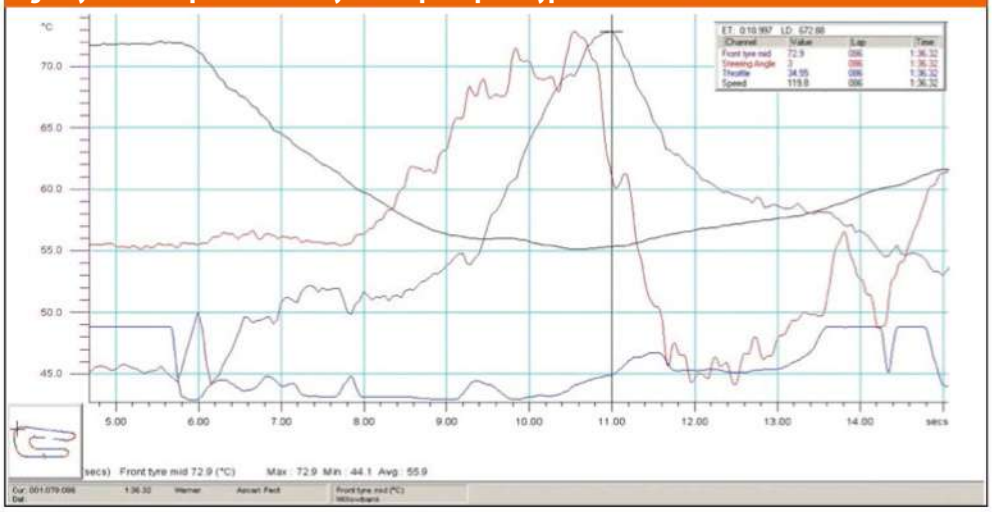
The terms of the equations are absolutely the same, but in this case the function is exponential as opposed to square. Some typical values for this are shown in **table 2**.

Table 2: typical values for the exponential function

Parameter	Value
T_{opt}	373.15K
k_{pre}	4
k_{post}	4
k_{PRE_MULT}	0.7
k_{POST_MULT}	0.8
T_{scale}	50

Graphically, this will look like **figure 5**.

Fig 3: tyre surface plot for an early 2000s sports prototype



Now let's discuss the pros and cons of both of these functions. Firstly, let me say I've used both of these functions for various race tyres and they have both worked out really well, depending on the application.

Where the square function shines is the fact it is robust up to the point of peak temperature, and just a bit beyond it. It balances that fine line between increasing sensitivity and not compromising robustness.

Where it does fall down, however, is in driver-in-the-loop models, particularly for amateur drivers who are prone to fry tyres. That said, you can manage that risk quite nicely by manually editing the traction circle radius vs temperature and load function in ChassisSim. Remember, though, *any* tyre model you use is an approximation and, if you have to make modifications, make them.

Where the exponential function shines is when you need something that is very sensitive but has some built in robustness in the post-temperature zone. If we examine both **equation 3** and **figure 5**, we have a lot of in-built robustness in the post-temperature zone. That way, if your driver fries the tyres it's not the end of the world.

Muppet racing

Figure 6 neatly illustrates this with an overlay of lap time simulation vs myself on DiL for a live axle V8 Supercar at Sydney Motorsport Park.

Note the difference between my driver inputs and the throttle inputs vs the lap time simulation. I'm being far too rough, but it doesn't have a huge impact on the fundamental handling charactistics of the car. If we look at the bottom plot, which is the stability index, there are a few differences (which you would expect) but the deltas aren't massive. That shows that even when you have a muppet in the DiL rig, it won't do anything silly on you.

However, the greatest strength of the exponential model is also its greatest weakness. If you have a tyre with a very narrow temperature window, the exponential model works really well. However, if you try to use it on a less sensitive tyre, you will struggle.

Fig 4: plot of the temperature square function

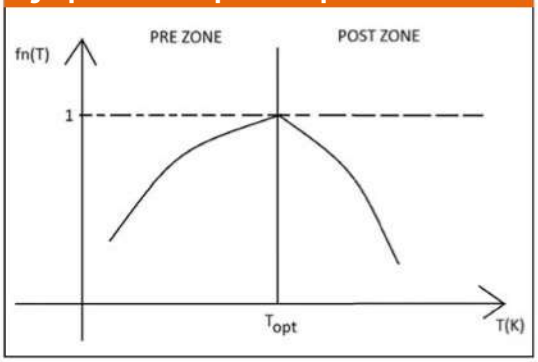
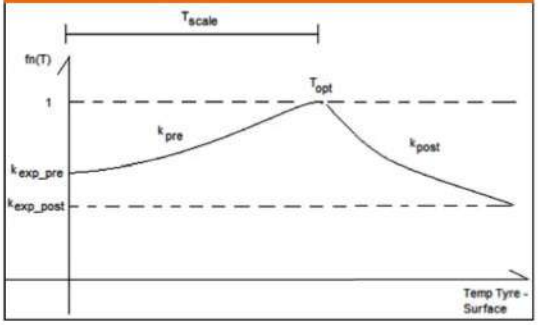


Fig 5: *fn(Ts)* of the exponential function



So, how we dial all this in? In the ChassisSim space, you start with the tyre force modelling toolbox. Note here that one thing you will typically have to do is increase the grip factor for the lap time simulation because most drivers overshoot the runway in terms of peak slip angle and slip ratios, so they'll heat the tyres more.

That is one thing to be mindful of when you switch to lap time simulation.

Ultimately, the proof is in the pudding, and **figure 7** shows the correlation of a live axle supercar with the exponential tyre model turned on (actual coloured, simulated black).

In terms of speed, steer angle and throttle (apart from an overly zealous right foot at the start), throttle and accelerations are identical.

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Fig 6: Overlay of lap time simulation vs driver-in-the-loop using an exponential tyre surface model

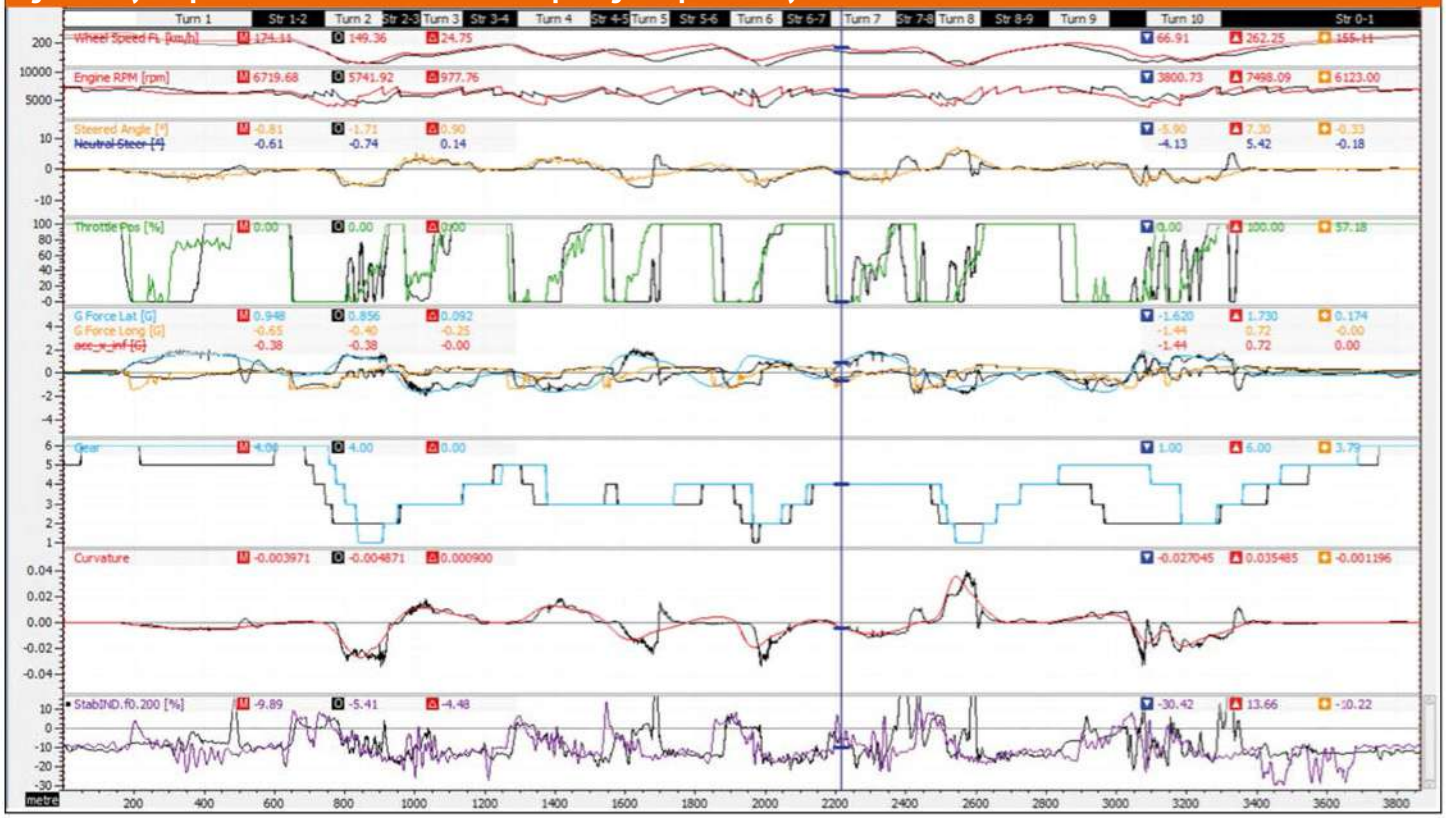

Fig 7: Overlay of actual data vs a thermo' tyre temperature model for a V8 Supercar

When do you use this? You use a tyre temperature model when you need increased set-up sensitivity for the lap time simulation, or need to punish wayward driving on a DiL simulation.

When we reflect on tyre pressures, note the internal tyre temperature is much slower acting than its surface counterpart.

Where the surface temperature component kicks in is when things are much faster acting - so when the driver inputs are too abrupt and / or you have a tyre that is very sensitive to set-up changes. That is when you use the surface temperature aspect.

However, if a 2D tyre model is working for you, then stick with that.

In closing, tyre surface temperature modelling is a powerful tool for understanding what your tyres are doing, but you have to choose your modelling very carefully. The pay off once you get through all this is you'll have a very detailed tyre model that can capture many aspects of the tyre behaviour, and that is a very valuable tool in your armoury.

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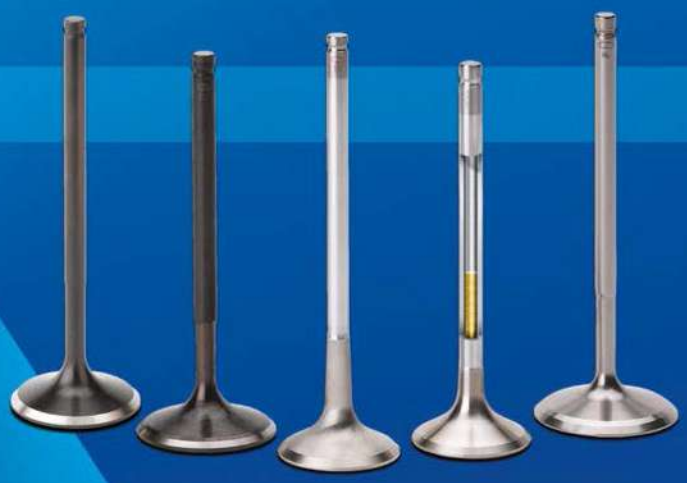

Science in action

How the current Japanese Super Formula car ended up as the chosen vehicle for a new, UAE-based autonomous racing competition

By DANIEL LLOYD

ASPIRE, a branch of the Abu Dhabi government's Advanced Technology Research Council is running the project, and has drummed up some significant financial backing. The prize pot is $2.25m

Super Formula is one of the fastest single-seater series in the world and, alongside Super GT, is one of Japan's two biggest motor racing championships.

For several years, its cars have raced domestically at iconic circuits like Fuji, Motegi and Suzuka, fostering the best homegrown talent and testing some big name overseas drivers who have taken up the challenge.

Last year, Super Formula introduced a new car, the SF23, built by renowned Italian racecar constructor, Dallara. Toyota and Honda supply their affiliated teams with bespoke, 2.0-litre racing engines that produce around 550bhp, while the SF23 has all the visual hallmarks of an advanced single seater.

However, Super Formula won't be the only place you can see these machines in action next year as, on 28 April, at Yas Marina Circuit in the United Arab Emirates (UAE), a field of 10 custom-built SF23s will gather to race.

AV initiative

Is this some grand attempt from Super Formula's promoters to expand their series' global outreach, like when Super GT joined the DTM grid at Hockenheim in 2019? Not quite. Rather, the customised SF23s at Yas Marina will be taking

part in a driverless competition called the Abu Dhabi Autonomous Racing League (A2RL). The initiative is aimed at furthering autonomous vehicle (AV) technology and raising public awareness of its potential through the medium of motorsport.

The entry list will comprise university teams from institutions based in China, Germany, the United States, Italy and elsewhere. Track testing is already under way and the winter will be a busy time for the organisers and teams involved as they gear up for an ambitious event that hopes to break new ground for AV motorsport.

The A2RL project is run by ASPIRE, a branch of the Abu Dhabi government's Advanced Technology Research Council. Big backing is evident, considering the $2.25 million prize pot on offer. So, rather than using some decommissioned single seater from seasons past (which would probably be a cheaper and easier option), the organisers went for a relatively young product in the Dallara SF23.

How did it come to pass that such an up-to-date, high-performance racecar entered this alternative application so early in its life cycle? And how does the A2RL machine differ from the SF23s that can lap under 10 seconds off a Formula 1 car around Suzuka with a driver behind the wheel?

Italian connections

According to ASPIRE executive director, Tom McCarthy, there were existing connections between some of A2RL's hired engineers and staff at Dallara, both of whom hail from the same industrial epicentre in northern Italy.

Furthermore, some of the initial A2RL teams, such as PoliMOVE (Milan Polytechnic), TUM Autonomous Motorsport (Munich Technical University) and the UAE Technology Innovation Institute have competed in the Indy Autonomous Challenge with a Dallara-built Indy Lights car. Therefore, there was familiarity with Dallara products at both the organisational and competitor levels.

ASPIRE considered using the Indy Lights-derived Dallara AV21 that was developed for the Indy Autonomous Challenge, where impressive speeds of up to 180mph were achieved on oval circuits. However, it was keen to do something different and go even further in terms of base car performance. After discussions with Dallara, ASPIRE went to Japan Race Promotion, which holds proprietary rights to the SF23, and successfully attained usage of the vehicle for the A2RL competition.

'There was a huge act of faith from JRP and Dallara to allow us to take their beautiful Super Formula car and start the re-design that would be required for what we're calling the Emirates Autonomous Vehicle 2024,' says McCarthy. 'Why take a Super Formula? Why not just take a Formula 4? Because we really want to go to the limits here. We can't do a Formula 1 car, but the best thing after that is Super Formula.'

ASPIRE then reached deals with other partners, such as Meccanica 42, which developed a new, high-performance alternator for the AV, something that was required to power the car's onboard computer.

ASPIRE's executive director, Tom McCarthy

The initiative is aimed at furthering autonomous vehicle technology and raising public awareness of its potential through the medium of motorsport

The SF23 was built and developed for the Japanese Super Formula series. Aside from a lack of Halo on the A2RL cars, the primary difference will be the autonomous stack in place of a human being

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Another partner that joined is also of Italian descent, Danisi Engineering, which integrated the autonomous stack (consisting of sensors and cameras) into the chassis.

Meanwhile, experienced Japanese outfit, Team LeMans, helped with the development, Yokohama provided its confidential tyres and Brembo supplied the brakes, as it does in Super Formula.

All driverless SF23s will be built specifically for the A2RL, rather than being converted from Japanese racing spec.

Adapted for autonomy

The main difference between the SF23 and the A2RL car is, of course, the absence of a driver, and the installation of an autonomous stack in their place. This will perform the functions of a driver, reading the road and generating actions such as steering inputs and throttle applications, depending on what it records. The stack consists of:

- Seven Sony IMX728 cameras with 360-degree coverage
- Four AF ProWave RADAR sensors
- Three Innovusion Falcon Kinetic FK1 LiDAR sensors
- One Neousys RGS-8805GC computer

According to McCarthy, the stack is only about 10kg heavier than a cockpit with driver, though the total car weight is 20kg higher than the SF23 in Super Formula trim.

'Things like the sensors are pretty light components,' he says. 'The cameras are tiny things. Even the LiDAR [Light Detection And Ranging] is not that big. The weight distribution, in terms of the focus of the energy, is about the same, but the stack makes it run a few kilos heavier because there are a lot of hydraulics for the drive-by-wire system.

'There is nothing different in terms of set up on the rest of the car, or in terms of the tyres and brakes, they're all absolutely identical.'

The onboard computer processes the data the cameras and sensors record. Like any computer, it requires cooling to function, so the car is fitted with an extra set of vents in the nose, running up through where the driver's legs would be.

The A2RL car also lacks a Halo head protection device and brake lights, both of which are unnecessary in a driverless racecar.

Each team will be given an autonomous racecar that can perform all the basic functions. It's up to them how they make it go quickly

The latter part has been replaced with rear-facing cameras that feed information to the stack. Aside from those differences, it looks very much like a standard SF23 that races in Japan.

Under the bodywork, the engine is different from what Super Formula teams use. Indianapolis-based 4 Piston Racing was contracted to develop a race-tuned version of a 2.0-litre, four-cylinder unit derived from the Honda Civic Type R. Despite sharing the same displacement, this is not the same power unit as that used in Super Formula.

The front and rear suspension are both pushrod operated, as in the Japanese series, and have adjustable dampers.

Keys to success

The A2RL autonomous stack consists of spec components, so the competition is mainly about how teams synthesise, interpret and apply the data generated from the cameras and sensors. Teams will use the same operating system, ROS2, to work with the data, but will have the freedom to code the cars how they wish using their own software on the side.

Team will be given an autonomous racecar that can perform all the basic functions. It's up to them how they make it go quickly. This relies not only on savvy coding knowledge, but also a sound understanding of what comprises an effective mechanical set-up.

The SF23 racers will be built by Dallara in Italy exclusively for use in the A2RL, though Japan Race Promotion holds proprietary rights to the design and agreed to its use in the new AV racing league

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The first prototype SF23s are already testing in the UAE to ensure chassis set-up and reliability is optimised. The human seen behind the wheel here will, of course, not be present on race day

'The drivers are taken out, but the motorsport challenge isn't,' McCarthy insists. 'We're making sure it doesn't come around to there being this genius software programmer who doesn't know a thing about motorsport and wins. That's not going to happen.

'The really demanding stuff for the teams is how well they can construct the element of the coding that we call the planning module. This takes into account whatever challenges we give them on track.

'Coding is the critical aspect of this race, but coding alone is not sufficient to be able to perform well and win.'

The challenges McCarthy mentions are yet to be defined, although his team has plenty of ideas, from single car time trials to multi-car races. The latter gives A2RL a greater emphasis on head-to-head racing than other previous attempts at autonomous motorsport, such as Roborace and Indy Autonomous Challenge. However, for many motorsport followers, it will always be difficult to resonate with a driverless spectacle, however many cars are on track.

Data testing

A2RL testing is currently in its 'early stages', according to McCarthy. When we discuss the project over a video call, he is walking around the garage during a mid-November session at Dubai Autodrome. It involves running a prototype SF23 with ex-Formula 1 and current Lamborghini LMDh driver, Daniil Kvyat, behind the wheel. This is standard racecar testing, to sort out the mechanical characteristics and reliability. But it's also the final stages before the serious track action moves on to a second prototype with the autonomous stack in place of the driver.

Bench testing of the stack occurred earlier in the year and a shakedown was held in September. Throughout the process, all

While teams will be given a fully functioning, well set up racecar, the idea is not to remove the mechanical engineering aspect entirely

'Coding is the critical aspect of this race, but coding alone is not sufficient to be able to perform well and win'

Tom McCarthy

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The impresive Yas Marina Circuit in Abu Dhabi is the venue for the new series, which has exclusive use of the facility throughout the second half of April, with the race itself taking place on 28 April

the testing data has been fed back to the teams, who can prepare in advance of being given their competition cars after winter.

'We will freeze where we're at, at the end of December,' says McCarthy. 'One of the real purposes of the testing is data collection. Each of the participating teams will be able to train their software on the simulator. They will have the car performance data that we do in testing, and that will be continuously updated. Then, we will do the assembly of the competition cars in February, in the UAE.'

'Every team will be working in a collaborative way. They won't be giving each other software, but there is a point where you work collaboratively to push the boundary. When you get to race day, that's when you compete'

Tom McCarthy

For this latter part, ASPIRE is assembling a group of mechanics and performance engineers who will then be on hand to support teams leading up to and during the competition.

'From the middle to the end of April, we have exclusive use of Yas Marina Circuit from 8am to midnight,' adds McCarthy. 'We have a run plan that each team will go through on each day. The date of 28 April will be a culmination of six weeks of team training and two weeks of intense practice.

'In the best nature of science, it's about collaboration and competition. In F1, each team is hermetically sealed. Here, every team will be working in a collaborative way. They won't be giving each other software, but there is a point where you work collaboratively to push the boundary. When you get to race day, that's when you compete.'

Public acceptance

McCarthy hopes that A2RL, with its combination of an extreme racecar and promises of more than two cars racing each other, will be a positive step for autonomous driving in multiple ways. There is, of course, also the potential for software development based on what the teams discover, and he sees potential in the series to bring members of the public on board with AV technology.

'It brings about greater opportunity for consumers to say this could be safe,' he suggests. 'At the moment, we're at Level 3 autonomy in cars. People are scared when we put in certain types of assists. They're turning them off. It doesn't feel as if they're being helped, but as if they're losing input. We've got to start bringing people along.

'In the more general sense, people are scared of AI and what it does to them. We're going to be using AI here, so we need to make sure consumers are involved in its incorporation so they can see how it can be something positive.'

McCarthy is adamant that ASPIRE isn't trying to replace motorsport as we know it. Racing is appealing because it puts us fragile humans in control of extremely complex machines. Occasionally, the human loses control, which often makes it even more exciting. That thrill, that danger, is lost in autonomous racing, but McCarthy reckons there are other interesting gains, including a chance to feed into road-relevant technology, as well as a platform for young engineering talent to shine.

'We're all very clear that nobody is replacing the motorsport of the driver. Who would want to do that?' he asks. 'But what about developing something in parallel that is utilising extreme sports, with science in action?'

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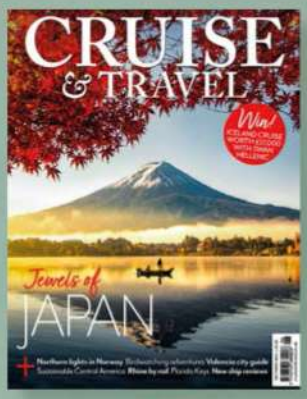

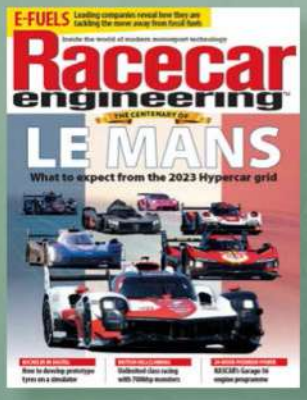

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Cars and stars to light up Autosport International

For the first time, drivers will be joined by their cars on stage at the leading motorsport show

For more than 30 years, Autosport International has been the leading show for everyone involved in motorsport. The four-day event, taking place between Thursday 11 and Sunday 14 January 2024, continues to combine business, engineering, thought leadership debates and live action but, for 2024, there will be a whole new look and feel to the show.

As usual, the Thursday and Friday are a trade show for the motorsport and automotive industry to network, see the latest innovations and to kick start the new year together. Then, on Saturday and Sunday, the doors are opened to the public for enthusiasts, amateur racers and job seekers to see their heroes and learn from the best.

The all-new main stage will allow cars to be driven from the '*parc ferme*' into the fan areas for the first time, bringing the stars and cars together at Birmingham's National Exhibition Centre (NEC).

The main stage will feature an array of cars and top personalities, from F1 team principals to Le Mans winners, Touring Car stars to grass roots motorsport heroes.

Leading the line up at this year's show, Haas F1 team principal, Guenther Steiner, will speak live on Saturday, giving his take on the 2023 F1 season, Haas' chances in 2024 and the secrets of running an F1 team. Hosted by Sky Sports' David Croft, the voice of modern F1, expect unfiltered banter on the world of F1.

There will also be a focus on sportscar racing, with Britain's most recent Le Mans winner, James Calado, accompanied by his Ferrari 499P on Saturday. Calado hit a new career pinnacle with an outstanding overall victory at the 24 Hours of Le Mans in June.

Also driving onto the main stage will be the Porsche 963 of Hertz Team Jota, which competed in the FIA World Endurance Championship this season. Team owner, Sam Hignett, will join the car on stage and give an exclusive insight into the team's first season in the Hypercar category, and its ambitions for 2024.

Completing a phenomenal selection of WEC content, Vector Sport's Gary Holland will also be on stage conducting a Q&A as the team looks to enter WEC and the 24 hours of Le Mans with its all-new Isotta Fraschini Tipo 6 Competizione Hypercar.

Attending the show

Autosport International will take place between 11 and 14 January 2024 at the NEC in Birmingham.

There is covered access from Birmingham International railway station and Birmingham airport. For those arriving by car, there are over 15,000 parking spaces (payment to the NEC on departure).

The NEC is clearly signposted from all west midlands motorways and major routes, including the M42, M40 and M6. Just pop B40 1NT in your sat nav and it will guide you to the NEC Site. Once there, please ignore the sat nav and follow the digital screens for directions to the car parks.

Tickets are available to buy now: www.autosportinternational.com

Leading the proceedings are an esteemed group of hosts. As well as Croft, Natalie Pinkham and Paul O'Neill will be front and centre on the stage guiding the stellar line up of motorsport personalities.

On Saturday and Sunday, the main stage will feature a broad mix of motorsport talent. Stars of the BTCC, TCR UK, NASCAR Whelen Euro Series, the British Superbike Championship and British Rally Championship will rev up to the stage for their interviews.

They will be joined by the public crowning of the 2024 Autosport BRDC Award winner. Former recipients include Formula 1 drivers, David Coulthard, Jenson Button, George Russell and Lando Norris. The winner of the highly coveted award will be on stage to talk about their career so far, the Formula 1 test and their next steps on the road to F1.

Tickets for this unmissable event can be purchased from the Autosport International website at www.autosportinternational.com

High-octane thrills as the Live Action Arena returns to NEC

Spectacular motorsport action is guaranteed at Autosport International with the return of the jaw-dropping Live Action Arena.

Birmingham's NEC will once again reverberate with the hair-raising thrum of revving engines from a diverse range of categories. World class talents from disciplines including Rallycross, motorcycles and Stock Cars will thrill the 3000+ Live Action Arena audience during a 45-minute feast of stars, stunts and all-out action.

Public day tickets include access to the spectacular show.

Autosport Engineering: where the motorsport world meets

Visitor research shows that over 60 per cent of trade visitors attend Autosport International to keep up with what is happening in motorsport, and 85 per cent of attendees are key decision makers. This makes the show an unparalleled opportunity to showcase and network with an international audience, particularly as it is the first industry networking opportunity of 2024.

Located in the heart of the show, Autosport Engineering offers trade visitors an exclusive opportunity to meet with like-minded professionals, discover the latest industry innovations and collaborate with new business partners.

This zone offers an unparalleled opportunity to network with an international audience, at the best time of the year to reach influential leaders from across the industry.

A revitalised Engineering hall, developed specifically for trade, suppliers, buyers and professionals, launches in 2024.

Expanding to open across all four days of the event, the popular Autosport Engineering trade show continues to showcase innovations for automotive and motorsport, as well as highlighting the technology and knowledge transfer between motorsport, aerospace, energy, marine and defence.

Discover the latest industry innovations and witness the technology transfer between motorsport and other engineering disciplines

Business Forum: the conference that goes beyond motorsport

The motorsport and automotive industry is set to shine a light on innovation at Birmingham's NEC between 11 and 12 January 2024 for the Autosport International Business Forum.

The two-day conference will welcome some of the industry's most exciting and innovative thought leaders to talk about everything from engineering and future mobility, to opportunities for people from all backgrounds to pursue a career in business and STEM.

Leading the conversation will be former head of strategy at Aston Martin F1 and Sky Sports analyst, Bernie Collins, whose wealth of experience will inspire the next generation of engineers. She will host many of the panel discussions.

Confirmed names include IMSA engineer Bill Pearson, Martin Popilka from P1 Fuels and Richard Frith, head of vehicle performance at Alpine F1 Team.

'The line up this year is the best and most diverse we have ever seen'

Ben Whibley, Autosport International events director

Meanwhile, representatives from Extreme E will discuss motorsport's future, and what other series and firms can learn from its all-electric racing.

Admission to the Forum is included with any trade day ticket to Autosport International.

Ben Whibley, Autosport International events director, talks about the 2024 Business Forum: 'We're very excited to host the re-launched Business Forum at Autosport International. As a key area of Europe's leading motorsport show, we're going to be showcasing some of the breakthrough projects that will shape motorsport and the wider world for decades to come.

'The line up this year is the best and most diverse we have ever seen. I look forward to sharing more updates in the weeks leading up to the show.'

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IN BRIEF

Mahle Powertrain has opened a new state-of-the-art battery development centre in Stuttgart, Germany. Battery development at the facility will go from initial prototyping to small-scale production and applications will range from e-bikes to trucks. The facility follows the recent creation of a vehicle and battery centre in Northampton, UK.

Formula 1 engineering icon, **Rob Smedley**, has launched Global Karting League (GKL), a new initiative aimed at levelling the playing field and increasing participation in motorsport from under-represented groups, with a commitment to fairness, identifying young drivers and inspiring the next generation of STEM talent.

The **24 Hours of Le Mans** has sold out of race tickets to the 2024 edition, within hours of going on sale to the public. Those available now are only for the test days, practice and qualifying.

Pirelli has been confirmed as the sole tyre supplier to the FIA World Cups in Macau for three years, starting in 2023. The Italian tyre manufacturer has supplied the FIA Formula 3 Championship since 2019.

Pirelli has also been confirmed to supply **Ginetta's** racing events until 2025 with its P Zero Trofeo R and P1 Cinturato slicks.

Bloodhound, the British Land Speed Record programme, has launched a campaign to find a backer to complete the record attempt, and also a new driver to pilot the car. Andy Green, the current record holder, remains on the team, but will not drive the car in future record attempts.

Ferrari launched a track day version of its LMH 499P Hypercar in late October. The Italian manufacturer is expected to make 30 of the cars, which will be run by a new Sport Prototipi Clienti programme. The car will not have the same restrictions as the racing version, so will feature full four-wheel drive and a push-to-pass function, which offers an extra 120kW of power. The company has partnered with Pirelli who will supply tyres specifically designed for the car.

Aston Martin confirms Le Mans return

The legendary British name was in, and then out, and now under new management is back in again, aiming for IMSA and WEC competition in 2025

Aston Martin has confirmed its long-anticipated return to the Le Mans 24 hours with a version of the Valkyrie track day car, which will compete in the LMH Hypercar category.

The British firm said it would race at Le Mans when the Hypercar regulations were first announced, but later retracted its position.

Under new management, the company will enter the series with partner team, The Heart of Racing, which was formed in 2014 and run by current driver, Ian James, who also acts as team principal.

Designed at the new Aston Martin Racing headquarters just outside Silverstone in the UK, the car will undergo significant changes compared to the donor car, which had already dropped the hybrid system from the track day original.

'Fundamentally, the wetted surfaces will pretty much all change subtly,' says Aston Martin's engineering director, Adam Carter. 'The chassis will be the same, the doors – let's say the bodyline – and we want to try and keep that as a Valkyrie. Maybe in the lower parts of the body there will be some changes but you won't see them.

'We have to shed downforce to be in the performance window and, whilst doing that, there are other opportunities to make sure the car performs across all the circuits, all track conditions, and also with different drivers.'

The Hypercar class comprises the LMH and LMDh category cars, which are all measured for aerodynamic efficiency, weight and power.

When the Valkyrie was originally announced for the category, rival teams were asked to increase the power demand to help Aston Martin bring its car into the same performance window. That meant teams such as Glickenhaus had to change supplier to meet the new power demands, while others had to invest a large amount of money to uprate their power units.

Once the Valkyrie programme was shelved, power levels came back to more realistic targets and the convergence between the two prototype concepts became possible.

As well as reducing downforce, Aston Martin must also shed power to bring it into line with the demands from the series.

'You are carrying more capacity [than needed] and with that comes more material,' concedes Carter. 'It's a bit longer in the wheelbase and the c of g is a bit higher, but where it is strong is it's V12, naturally aspirated engine that is phenomenal in terms of torque response.

'So, where you are looking at a championship that is all about closed loop torque control, it comes as a significant element.'

Aston Martin will work on the engine power reduction with Cosworth, and also look at improving fuel consumption, as well as mapping the car to operate with the torque sensors that are fitted to the prototypes.

The chassis will be built by Multimatic, which will also be present in the WEC as chassis supplier to Porsche, and constructor of the Ford Mustang GT3 car.

Testing will begin in 2024 and racing programmes include IMSA and the FIA WEC in 2025.

Ginetta reveals GT4 Evo

Ginetta, the renowned British manufacturer, has revealed an updated version of its GT4 car.

Making its debut in the hands of customers next year, the G56 GT4 Evo builds upon the features of the original G56 GT4 that arrived on the grid in 2021.

The updated model, which completed a test race at Magny-Cours in late October, sports a comprehensive evolution package. In addition to improved cooling, it has enhanced tyre heat and degradation characteristics, achieved by adjustments to the suspension, roll development, a higher platform height and larger wheels and tyres on both axles.

Mike Simpson, Ginetta's director of motorsport, said: 'The 2024 G56 GT4 Evo is an upgrade in every possible area. We have had many cars circulating in endurance racing in tough climates over the last years and the Evo upgrade is the accumulation of listening to customers / teams and developing what we believe is the best GT4 car on the market.

New Evo version offers pumped-up looks, improved aero efficiency and increased driver comfort

'We have strived for greater top speeds within the Balance of Performance management, while adding weight lower down in the chassis gives us some wins in safety and torsional stiffness.'

Other noteworthy changes to the aerodynamic profile include a visually striking bonnet treatment and alterations to the rear wing, both contributing to gains in overall aerodynamic efficiency. There have also been changes to the cooling package around the engine and airflow into the cockpit, with improved air conditioning helping reduce temperatures for increased driver comfort.

Half of the proposed 20-car production run during the G56 GT4 Evo's first year of competition has been reserved by existing customers.

TOCA, IndyCar gaming on the skids

British Touring Car Championship rights holder, TOCA, has cancelled its agreement with Motorsport Gaming US LLC, known as Motorsport Games.

The agreement licensed Motorsport Games to produce interactive video gaming products relating to the BTCC. In a press release issued by TOCA, the body says the decision to terminate the agreement was 'due to ongoing fundamental breaches of the agreement by Motorsport Games. Having been given significant latitude to rectify those contractual breaches, unfortunately Motorsport Games failed to do so.'

The agreement was ended with immediate effect, and all licensed BTCC rights that were previously provided to Motorsport Games have been withdrawn. Other series have also cancelled their agreements with Motorsport Games.

LMP2 to increase speed in '24

The ACO will increase the rev limits for LMP2 cars competing in the European Le Mans Series next year and bring the cars back to 2017 levels of power.

This year, the cars were required to run with a 40mm air restrictor and limited to a maximum 8000rpm rev limit in all gears except sixth.

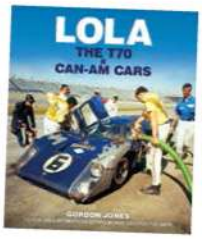
The cars will now be allowed to rev to 8500rpm in all gears, and the maximum fuel load they carry will be increased due to the biofuel that will be used in the series next year, which will increase consumption.

The changes will please customer drivers as the Gibson engines deliver more performance at the higher rev range. LMP2 cars were slowed in the 2023 World Endurance Championship to make way for the Hypercars, with fewer gear ratio options available, a less powerful rear diffuser and had to run the Le Mans low drag aero kit at all tracks (none of this was applicable to the ELMS teams).

To compete at Le Mans, cars will have to run in the same condition as they did in the WEC this year.

LMP2 cars will be able to run to their full potential next year, after being performance strangled through the 2023 season

Books



It has taken three decades for Gordon James to complete his book on the Lola T70 and the Can-Am models that followed from the T160 to the T310, but the end result is now available from EVRO Publishing.

The book includes an introduction by Eric Broadley detailing the Mark 1 sportscar and the company's route to the T70, as well as forewords by Richard Attwood and George Follmer.

Alongside the exhaustive research into the lead up to the T70 and its successors, every race from each of the series in which the company raced between 1963 and 1974 is covered. There is also a comprehensive list of every Lola, team and driver from this period.

The 576-page book features nearly 700 photographs, in colour and black and white, and retails for £95 from www.evropublishing.com

***Racecar Engineering* contributor,** Serge Vanbockryck, has completed an exemplary book on the TWR-Porsche WSC95 that delivered two wins for Reinhold Joest's team in 1996 and 1997, and won races in the US and the UK. The book includes a day-to-day history of chassis WSC 001 that is outlined in the incredible detail now expected of the author.

While the topic of the book is not an obvious one, it is a fascinating story nonetheless. The original plan was to build a Porsche-engined, Jaguar-chassis car and enter it into major endurance races, including the 1995 Daytona 24 Hours. However, IMSA's rules changed shortly before the race and the car was put into storage until Joest asked to run it at Le Mans in 1996.

Norbert Singer was involved in the project as Porsche had agreed to the plan, and Davy Jones, Manuel Reuter and Alex Wurz scored the first of two wins at that race for the chassis.

The car was then adapted to be used as Porsche's GT1-98 that raced in 1998 and finished second at Road Atlanta.

The 320-page book is published by Porter Press and is available now for £69 from porterpress.co.uk

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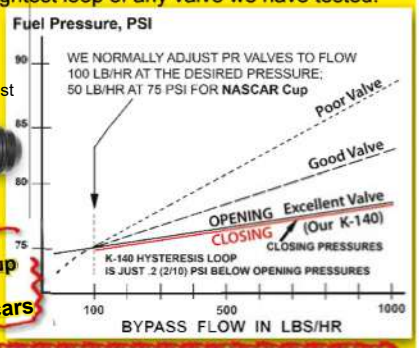

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Macau musings

Savouring the old-world charm of the island-based grand prix

The Macau Grand Prix might not have delivered the racing we have come to expect in the past, but Luke Browning was still a deserving winner of the Formula 3 race and Raffaele Marciello was the rightful winner in the GT race too. The track is a challenge for the drivers; narrow for the most part but features one of the most challenging corners in racing. Mandarin is taken at 280kph in a GT car, and there are no issues of track limits - get it slightly wrong and you are in the outside retaining wall. Walking down there during practice for the GT race this year provided an opportunity to fully appreciate the fury of a modern GT3 racing car and bravery of the drivers.

Browning, the Williams Academy driver, had the speed over the hill to pull a gap and the straight-line advantage to hold that gap, even on the high-speed section from the waterfront to the Lisboa Casino. Marciello was fastest in all sessions bar one in his Mercedes. On such a track, and against such opposition, despite the fact that they dominated their races, there were no complaints.

Pirelli opted to bring its medium compound tyre for the F3 race, rejecting requests from the teams for the hard tyre, and grip levels were high. There was a double weekend to celebrate the 70th edition of the race, and perhaps the rubber laid down from the previous races helped, although local traffic driving on the street track for four days in between made that assumption a little suspect.

This was the first time since 2019 that the track was able to hold the World Cups. Covid restrictions on travel meant extended quarantine periods for international visitors and, while a few chose to pay that price in order to compete, many didn't. The manufacturers stayed away during those years, which led to the racing being primarily for Chinese teams and drivers. While it was nice for the international community to return, the crowd seemed more interested in the local presence on the grid of Chinese and Asian teams. Chinese driver, Leo Ye Hongli, finished tenth in his Porsche, ahead of Matteo Cairoli, Kevin Estre and DTM champion, Thomas Preining, so the crowd had plenty to celebrate.

Access all areas

One of the most attractive aspects of Macau is the paddock, which is busy and chaotic. With the cars, teams and drivers all lining up in the paddock before heading to the track, it's a chance for the public to engage with the competitors on a level only otherwise seen at the Spa 24 Hours and the Nürburgring 24 Hours. The fact that fans can interrupt conversations to have their photos taken with the drivers or, in some cases, sporting chiefs such as Ferrari's Antonello Coletta and Porsche's Thomas Laudenbach who were both new to the race, or BMW's Andreas Roos, adds to the fun.

The paddock, however, is not very big. One moment of comedy came when a new, dark red Ferrari 296 GT3 was pushed out of its garage on dollies to go to scrutineering and rolled through a team of promotional models for one of the local casinos, just as a TCR car was being wheeled the other way, leaving the spectators, and a chef with his bowl of soup on wheels, very few options to get out of the way.

When there was a crash in the TCR race, a fork-lift truck was dispatched to rescue the car from the track. The fact it went out with three workers on it, and came back with only one was mildly concerning, but not all that surprising.

Mandarin is taken at 280kph in a GT car and there are no issues of track limits

Serious business

The fun of Macau is attractive, but there is a serious side. The pits are based in what is a fully working bus garage when the race isn't on, and there is very little room for the teams to work. That includes Pirelli, which was given one garage to store and fit tyres for nearly 60 cars competing that weekend. The cramped conditions meant that the fitting protocols could not be well followed and when a tyre exploded off its rim while being fitted, the fitter was taken to hospital with a broken finger and damaged wrist. The roof of the pit was buckled in the incident, and Kumho next door consequently lent some of its garage space to give the fitters a bit more room to work.

There are changes in the pipeline that will affect the nature of the paddock, but which are probably overdue. The ferry that normally runs from Hong Kong airport to Macau only now runs three times a week, once a day. Traffic is encouraged to use a bridge that was expensive to build and opened in 2018, which makes the trip to and from the airport less fun. There is a new transfer area that has been built away from the track, and the rumour is that the old terminal will be rebuilt as a new race control centre. The paddock could then increase in size, which will be nicer for the teams, particularly those in TCR who currently work in the underground car park.

The race may lose a little of its charm, but the changes will secure better conditions for teams. Just so long as they don't touch the track. It remains one of the last big challenges in motor racing.

ANDREW COTTON Editor

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With unique Fade Resistant Technology™, Halo P1 has a far lower and far more stable level of compressibility over a wide temperature range than the competition—giving drivers the confidence that their brake fluid will perform as well on the last lap as the first.

Formulated for the art of braking.

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